ASSORISORSE

Italian Sustainable Energy & Resources

Assorisorse Methane Emissions Working Group

The commitment of Italian industry to reduce methane emissions

INDEX

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METHANE EMISSIONS – THE OVERALL PICTURE

The topic of methane emission is a hot topic at a global and European level.
The European Commission published a proposal for a regulation on methane emissions reduction in the energy sector on December 16th, 2021. The proposal is meant to support the widespread development of a robust MRV (Monitoring, Report and Verification) standard for methane emission in the energy sector, to put into EU law an obligation on leak detection and repair (LDAR) and ban venting and flaring.
The impact of the regulation will be huge and therefore the proposal has been analyzed by most operators and key stakeholders, both at/ European and national levels. The proposal is currently being discussed both by the European Parliament and the Council of the European Union. The use of hydrocarbons must be accompanied by a significant reduction in methane emissions, as part of a strategy that aims at carbon neutrality: this reduction, to be applied to any type of emissions, involves the entire industrial chain (operators, engineers and technology suppliers), as well as institutional stakeholders and regulators.
The Italian industry made an important commitment to reduce methane emissions and important results are already being recorded, with objectives that have been achieved, by some of the main operators, years in advance, thanks to the commitment of the entire Italian industrial chain, represented by the Association.
Assorisorse is committed to support public decision makers and key stakeholders and engaged in constant monitoring and proposal action – at European, national, and local level – relating to legislative and regulatory activity, and collaborate with various national and international bodies, creating synergies that favor business operations and developing common strategies on core topics. Specifically, the Association has decided to commit itself, also through the establishment of an ad hoc working group.
Assorisorse's members are committed to reducing methane emission and support the implementation of a balanced and effective roadmap.

The Assorisorse working group on methane emissions has been established in 2021 to intercept the more and more urgent need to significantly reduce emissions into the atmosphere, whatever the origin and the reason: incident emissions from unplanned events, incomplete combustion, fugitive emissions, permeation, pneumatic, and vented emissions. The whole methane value chain is represented in the working group: technology providers, engineering and EPC contractors, operators, testing, inspection and certification bodies, and consultants. The need for reduction goes together with the need to report methane emissions correctly and transparently to the stakeholders and the community.
The work has the objective of giving the right information on what has been done and on what development projects and initiatives are currently in place and planned, with the ultimate aim of providing a contribution and indications for the various institutions, associations and parties involved, at local, national and European level.
The working group also addressed the key changes introduced by the proposal and highlights some of the "hot topics" under discussion to contribute to the final version of the regulation, such as the prescriptive nature of some of the requirements, the lack of specific requirements for the different segments of the gas value chain (up-mid-downstream), the lack of cost-to-benefit analysis to prioritize interventions and maximize the positive return of the investments, the timing for the implementation, and the consistency between current technical standards and future ones.
On April 17th, 2022, the working group officially provided feedback on the proposed regulation through EU website. Our feedback is very much aligned with those provided by national and international bodies.
Assorisorse collaborates with several organizations to create synergies that favor business operations and the development of common strategies, such as with ENTSOG, Eurogas, GERG, GIE, and MARCOGAZ.
The working group has analyzed the overall issue of methane emissions, an objective that must be pursued through actions on the entire supply chain, such as:

- the optimization and refinement of the methods and technologies used for the estimation of emissions (starting from the identification of the sources, to the use of adequate technologies for the measurement in the field, from the use of sufficiently detailed emission factors, to the correct application of correlation methods), including best available technologies (BAT) or monitoring reporting and verification (MRV) systems, with possible reference to recognized reporting systems, such as OGMP 2.0 Oil and Gas Methane Partnership;
- the definition of achievable, measurable and accountable objectives for the containment of emissions within a defined time horizon, with reference to industry objectives, such as the Global Methane Pledge or those recommended by OGMP 2.0;
- the preventive definition of intervention methods and best practices for the containment of emissions detected, in the immediate, short and long term;
- the overall assessment of the impacts and secondary aspects and the definition of a shared method for reconciling the estimated and measured data at the emission level with those relating to the emission of the entire plant.

In this global picture, **Institutional stakeholders and control bodies** are responsible for:

- the definition of a regulatory framework (both in terms of limits / objectives, both in terms of estimation and monitoring methods, and in terms of recognition of costs / incentives for regulated subjects) consistent with Community guidelines (in particular the expected European regulation on methane emissions being published by the European Commission);
- the implementation of a register of emissions (fugitive, punctual, unburned) periodically updated to monitor the evolution of the emission scenario;
- the definition and adoption of updated technical standards for Monitoring Reporting and Verification (MRV) and Leak Detection and Repair (LDAR) activities;
- the implementation of a verification procedure.

METHANE EMISSIONS REDUCTION

Operators are responsible for:

- the assessment of the applicability of the best available technologies in the construction of new plants and the adoption of best practices for operation & maintenance;
- the application of the most advanced and refined methodologies for the identification and subsequent estimation of emissions, based as far as possible on field measurements;
- the application of MRV and LDAR activities, aimed at reducing methane emissions consistently with the best available technologies;
- the implementation of an adequate reporting system consistent with the register system of the competent bodies.

Selected chapters from Assorisorse final document (which is written in Italian) are reported here, while some more detailed topics can be published in subsequent Issues of the SPE Italian Section Bulletin.

METHANE EMISSIONS REDUCTION

The document is structured as follows:

- **chapter 2** introduces the initiative of Assorisorse Group of Methane Emissions (2.1) and its objectives (2.2)
- **chapter 3** provides a background on the role of natural gas in Italy and worldwide (3.1), provides useful definitions on the various typologies of emissions of natural gas (3.2) and other greenhouse gases (3.3)
- **chapter 4** provides a background on applicable rules and regulations, internationally (4.1) and in Italy (4.2), as well as the Italian industry (represented by Assorisorse) view on the proposed EU regulations (4.3)
- **chapter 5** addresses best design practices to minimize methane emissions, by selecting the proper processes (5.2), machineries and equipment (5.3), commissioning and pre-commissioning (5.5), and start-up (5.6)
- **chapter 6** of the full document (not reported here) showcases a number of technologies developed or deployed by the associates to minimize emissions. These may be discussed in subsequent SPE Quarterly Bulletin Issues
- **chapter 7** addresses the best O&M practices to be used to reduce emissions both upstream, midstream and downstream (7.2) and the adoption of LDAR systems (7.3). In the full document, also some digital data strategies and instrument analytics for gas network inspection are described, not reported here (as chapter 6 and 9)
- **chapter 8** is focused on the best practices for the estimate of the emissions, referring to the main standards and methodologies (8.1), the various types of emissions (8.2) and the consolidated and novel technologies for field measures and data reconciliation (8.3)
- **chapter 9** of the full document (not reported here) shows the results obtained by some of our associate members to reduce their methane emissions, such as Snam (9.1.1), Energean (9.1.2), and Eni (9.1.3). The paragraph also addresses the issues of KPI definition (9.2) and communication of results (9.3). These applications may be discussed in subsequent SPE Quarterly Bulletin Issues.

2 THE ASSORISORSE INITIATIVE

2.1 ASSORISORSE

Assorisorse is the Italian Association for the Energy and Sustainable Resources Industry that brings together companies in the energy sector committed to enhancing the value of available natural resources through technological innovation and intellectual fertilization aimed at carbon neutrality and circular economy. Its mission is to decarbonize hard-to-abate industrial processes and promote environmental, economic and social sustainability.
The Association is part of Confindustria and is a member of the United Nations Global Compact. It includes Italian and international companies focused on issues such as: Domestic Resources, Methane Emissions, Circular Economy and Zero Waste, Hydrogen Supply Chain, CCUS, Critical Minerals, Sustainability of the Energy Supply Chain.

The Methane Emissions Working Group was formed in late 2021, with the aim of expressing representatives from across the relevant industry supply chain:
- operators of facilities for production, storage, regasification, transmission and distribution of natural gas
- EPC contractors, engaged in the construction and start-up of new plants and in the implementation of modifications, expansions and modernization of existing plants
- suppliers of machinery, plants and technology, involved in the definition of strategies to reduce emissions
- companies that provide instrumentation and hardware and software solutions to support operators
- engineering companies engaged in the definition and design of plants and the modification and expansion works, and in the areas of shutdown engineering, inspection, maintenance and asset integrity management
- consulting companies active in the areas of environment and safety, providing services related to the estimation and measurement of emissions and assessment of the resulting impacts
- companies that carry out field inspections and surveys- companies involved in independent verification, development of standards and best practices and actively participating in research and development projects.

2.2 THE AIMS

The working group has set itself a number of objectives in relation to the issue of methane emissions:
- the preparation of a summary framework of best available technologies and operational practices for the reduction, monitoring and reporting of methane emissions
- analysis of issues related to emission estimation, monitoring and field measurements and data reconciliation and reporting
- the promotion of unambiguously defined KPIs and reduction targets, with comparable data and repeatable measure
- the formulation of proposals for overcoming the current limits, in collaboration with other associations and institutions interested in the subject
- the preparation of a white paper (from which this document is derived)
- dissemination of the work done through the organization of events and seminars and participation in international industry conferences, such as OMC and Gastech.

3 THE INDUSTRIAL CONTEXT

3.1 THE ROLE OF NATURAL GAS IN ITALY AND IN THE WORLD

3.1.1 Trend in gas demand/consumption in Italy

Energy consumption in Italy has increased from 150 Mtoe in 1990 to a peak of almost 190 Mtoe in 2005, before declining to around 142 Mtoe in 2020 (Figure 3.1). The weight of gas in the energy mix has grown over time and, as of 2016, gas has established itself as the first energy source, overtaking oil.

In fact, gas covered 26% of energy demand in 1990 and in 2020 it represents 41%; in the same period the weight of renewables has also increased significantly, from 3% to 21%, while that of oil and oil products has decreased from 58% to 32% and that of coal and solid fuels from 10% to 3%; relatively stable are electricity imports, which represent about 2% of the energy demand.

In Italy, gas consumption is made up of an increasing share of imports and a domestic production that has steadily decreased

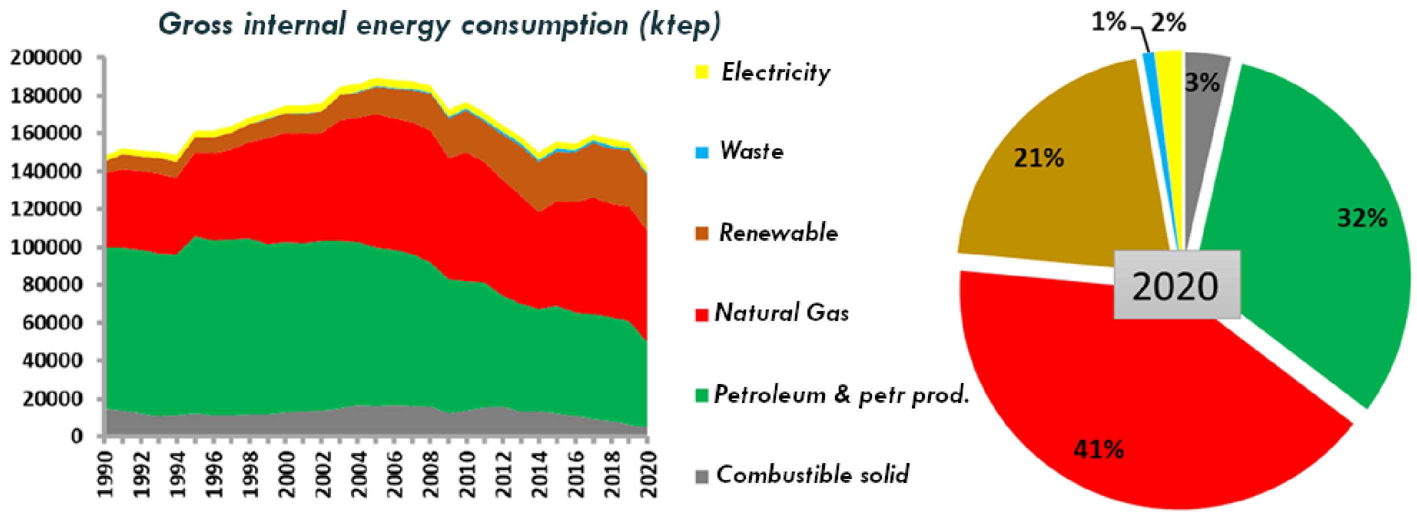

Figure 3.1: Gross inland energy consumption in Italy [ktep] (Source: Eurostat)

over the years due to the combined effect of field depletion and restrictive policies that have limited the interventions necessary for the complete exploitation of the national reserves, until reaching the minimum level of just 3.34 bcm in 2021 (Figure 3.2).

Foreign dependence has increased from 66% in 1990 to 94% in 2020 (Figure 3.3). Pipelines still account for more than 80% of total imports. The role of LNG, which was very limited in the 1990s, has grown and now accounts for nearly 20%, allowing for greater source diversification (e.g., imports from Qatar and the United States). In 2020, however, Russia and Algeria still accounted for 2/3 of national gas supply.

As a result of the crisis situation between Russia and Ukraine, a major political push to diversify gas supplies, both through pipelines and LNG, has emerged and the current situation is evolving rapidly.

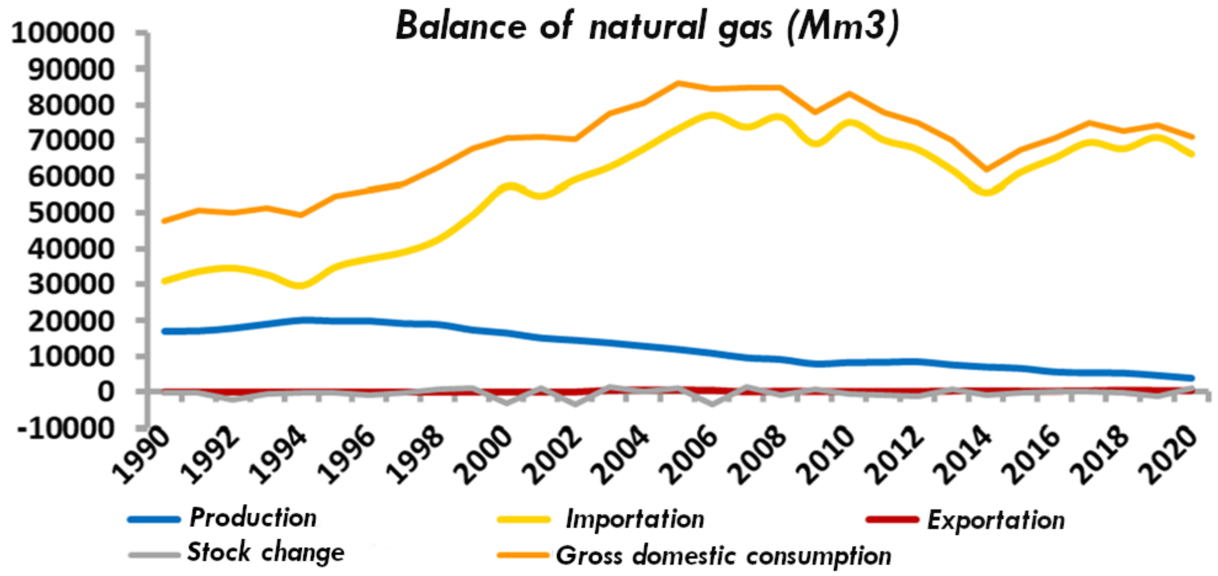

Figure 3.2: Natural gas balance in Italy [Mm3] (Source: Eurostat)

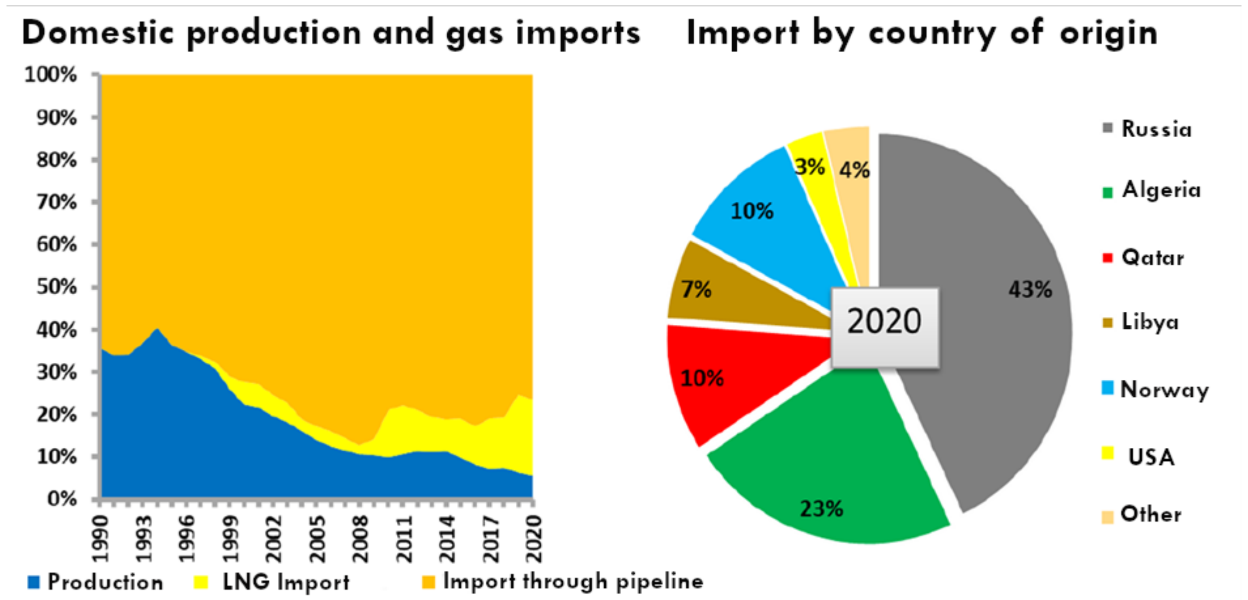

Figure 3.3: Domestic production and imports of natural gas (source: MiTE)

The entry points for gas into Italy are the six international gas pipelines and the three regasification terminals currently in service. Two gas pipelines reach Sicily, at Mazara del Vallo and Gela, three other entry points are on the Alpine border, at Tarvisio, Gorizia and Passo Gries, and the sixth - which came into operation in 2021 - is near Melendugno, in Puglia. The first Italian regasification terminal was GNL Italia in Panigaglia, near La Spezia, which had already been operational since the 1970s; subsequently, two more plants came into operation: Adriatic LNG in front of Rovigo (in 2009) and the FSRU Toscana, floating storage and regasification unit operating in front of Livorno since 2013 (Figure 3.4)

Figure 3.4: Italian network and entry points (source: Snam)

National gas demand, after peaking at 86 bcm in 2005, amounted to about 71 bcm in 2020 (demand then rose again to 76.1 bcm in 2021), as depicted in Figure 3.5. Final consumption accounts for 55% of demand. Civic, as the sum of residential and services, has been relatively stable over the last decade and accounts for nearly 28 bcm, while industry in steady decline since the turn of the century has fallen below 10 bcm. In spite of the growth of renewables, 42% of gas demand is for electricity generation for a total of over 29 bcm, a level also reached thanks to the reduced use of coal plants.

The future evolution of the demand for natural gas will depend on the speed with which the country implements the decarbonization process.

The EU energy transition policies propose very challenging objectives, which require a great commitment from the entire supply chain in order to support the growth and development of the economy. In any case, being natural gas the first energy source for use as well as the one with the lowest CO2 emissions among fossil fuels, it will play a key role in the national energy mix for a long time to come before making way for renewables. The replacement of gas with electricity in end uses is not always feasible and presents critical issues both from the point of view of the very high number of interventions required and from that of costs, which are still very high. Even in the electricity generation sector, where green technologies are more mature, in the absence of very significant innovations regarding batteries, gas will continue to compensate for the intermittency of renewables, guaranteeing the stability of the system. In addition to the availability of an infrastructural network already present and widespread, such as the Italian one, gas will also be able to support the path towards a low carbon economy, and at the same time promote the decarbonization of the same gas vector, through the development of renewable gases such as biomethane, hydrogen and synthetic gas.

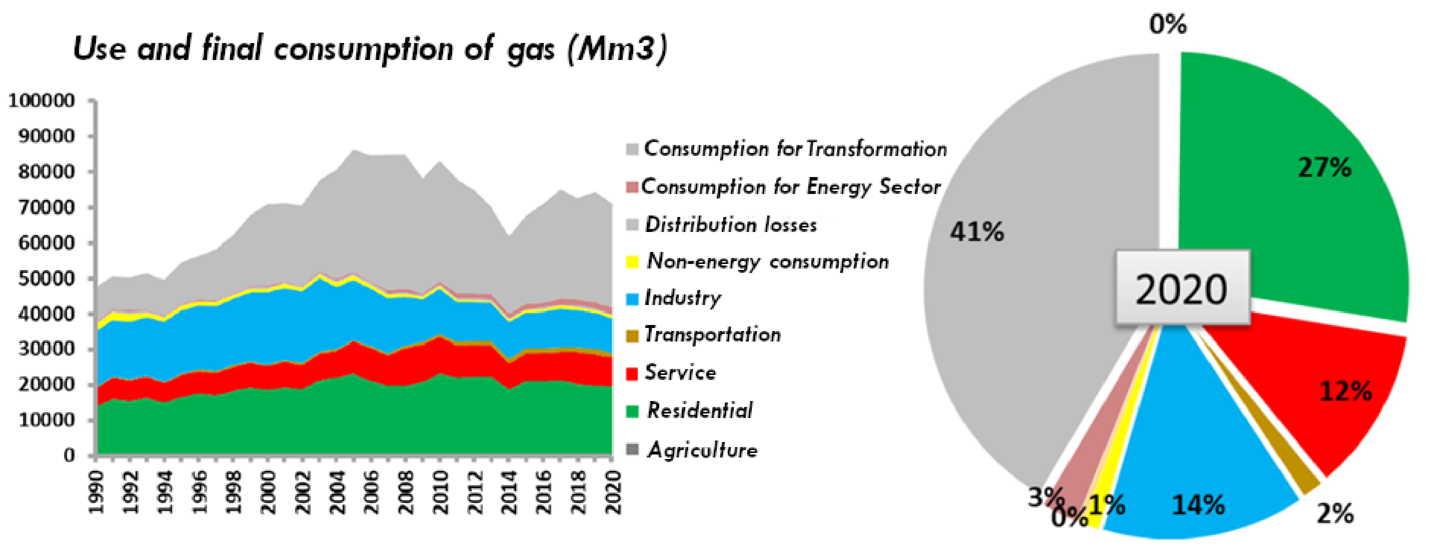

Figure 3.5: Use and final consumption of natural gas in Italy (source: Eurostat)

3.1.2 Gas Demand Scenario (Global Ambition)

The Global Ambition [1] scenario has been developed up to the years 2030 and 2040. Annual gas demand in this scenario is fairly constant, remaining above 70 bcm even in the long term. In 2025, gas demand of 72.2 bcm is sustained by the phase-out of coal. In 2030, the total demand for gas reaches 74.9 bcm, thanks to the growth of biomethane (3.4 bcm) and hydrogen (2.6 bcm of methane equivalent) that contribute to the decarbonization of end uses. In contrast to the Natural Trend (NT) Italy scenario [*2], the quantities of hydrogen projected to 2030 in the Global Ambition scenario are consistent with the developments envisaged by the “Guidelines for the National Hydrogen Strategy”. At 2040, biomethane and hydrogen are worth respectively 9.3 and 7.3 bcm per year (Figure 3.6).

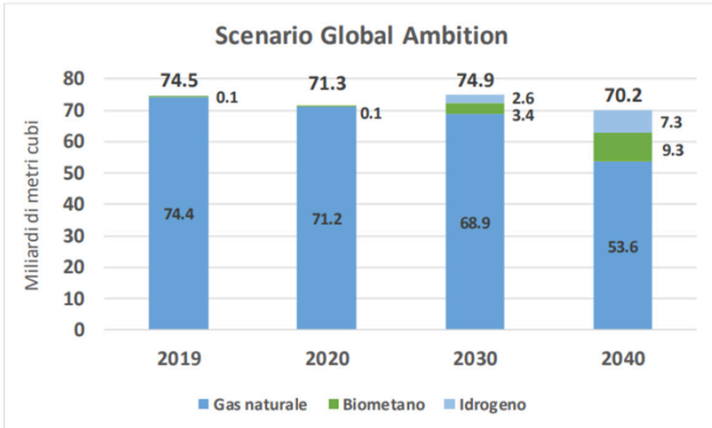

Figure 3.6: Evolution of total gas demand (GA)

Below is an analysis of the main consumer sectors:

- **Civil**: is considered in delay with respect to energy efficiency measures compared to the NT Italy scenario. Demand for gas in the civil sector remains essentially stable at current values until 2030 and then decreases in the next decade to reach about 21.6 bcm in 2040. The penetration of biomethane in the sector favours decarbonization: in 2030 about one third of the available biomethane is consumed in the civil sector while in 2040 the sector will ab sorb about 3.5 bcm.
- **Transport and bunkering:** in the Global Ambition scenario, consumption in the sector grows to reach around 8 bcm by 2030 (of which 1 bcm of biomethane). Growth is driven by an approximate doubling of CNG consumption and above all by the growth of LNG for heavy transport and shipping. In the period 2030-2040 the growth of LNG mobility continues, which is complemented by hydrogen mobility, which is established to reach 2 bcm in the decade. By 2040 the volumes of natural gas in land and maritime transport will be about 14 billion of which about 2 bcm of biomethane.
- **Thermoelectric and Derived Heat**: Consumption by thermoelectric power plants will continue to increase to about 30.3 bcm in 2025, due to the phaseout of most of Italy’s coal-fired power plants. In 2030, demand for thermoelectric power plants will decrease to about 21 bcm, due to the concurrent impact of an increase in imports of electric power and an increase in the availability of renewable generating capacity, while demand for thermoelectric power plants is expected to fall to about 15.5 bcm in 2040.
- **Other Sectors:** The other sectors of natural gas consumption are represented by consumption in the agricultural sector, non-energy uses of gas, consumption in the energy sector (extraction consumption, self-consumption by LNG plants and consumption by refineries) and consumption by transportation and distribution networks. In the Global Ambition scenario, it is assumed that overall consumption is reduced to about 1.9 bcm due to a reduction of about 1.2 bcm in consumption in the energy sector.

In the Global Ambition scenario, most gas demand continues to be met by foreign imports (Figure 3.7). The decline in domestic natural gas production is more than offset by growth in low-carbon gases.

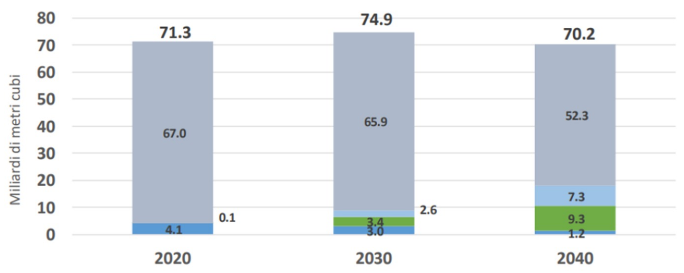

Figure 3.7: Gas supply evolution from 2020 to 2040 for the Global Ambition scenario

3.2 METHANE EMISSIONS

3.2.1 Methane as a greenhouse gas

Methane is the second most important greenhouse gas after CO2, characterized by an extremely high climate-changing power: it is estimated that it can have an impact 25-80 times greater than CO2, depending on the time horizon considered (100 or 20 years respectively).
Within the strategy aiming at carbon neutrality, the use of hydrocarbons must be accompanied by a significant tightening of their emissions, in each of the forms detailed in section 3.2.3 below, a tightening that must involve operators and institutional stakeholders and control bodies.
Figure 3.8 shows the percentage share of the main contributors to overall climate-altering emissions in Europe (2019 data [*4]).

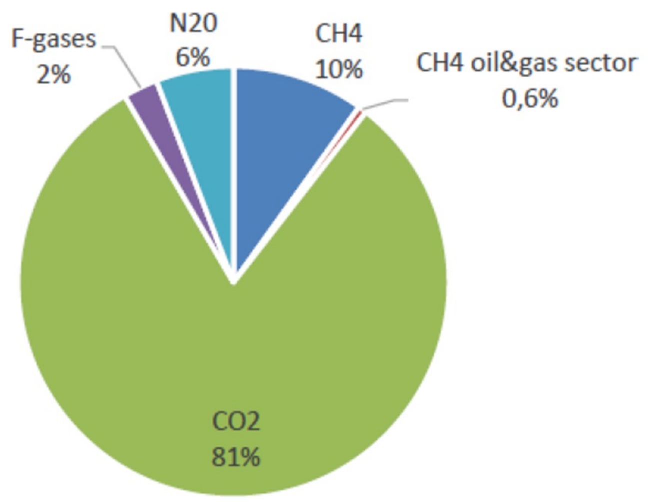

Figure 3.8: Greenhouse gas emissions in the EU (2019)

Figure 3.9 shows the percentage impact of the various sectors of human activity on methane emissions (10% of total GHG emissions, as shown in the figure above). The graph shows that the energy sector has an overall impact of 18%, of which about 6% is attributable to oil and gas installations.
Although the energy sector accounts for a limited share of total emissions, it has the greatest reduction potential for rapid, effective and efficient emission reductions.
It follows that the reduction of methane emissions is an essential element in achieving the EU's GHG emission reduction targets (55% reduction by 2030 and carbon neutrality by 2050) and fulfilling the Paris Agreement.

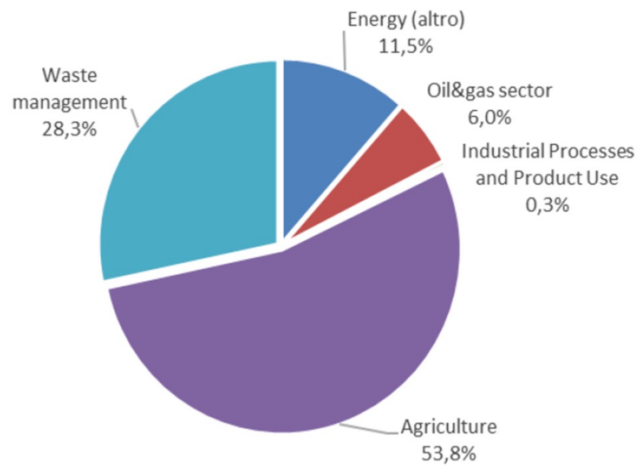

Figure 3.9: Anthropogenic methane emissions in EU (2019).

3.2.2 Emissions Scope 1, 2 & 3

The GHG Protocol Corporate Accounting and Reporting Standard guidance (issued in 2004 and updated in 2015) provides a standardized methodology for quantifying corporate greenhouse gas emissions. The Corporate Standard classifies a company's direct and indirect emissions into three scopes:

- Scope 1, direct emissions generated by the company, the source of which is owned or controlled by the company
- Scope 2, indirect emissions generated by energy purchased and consumed by society
- Scope 3, all other indirect emissions that are generated by the company's value chain.

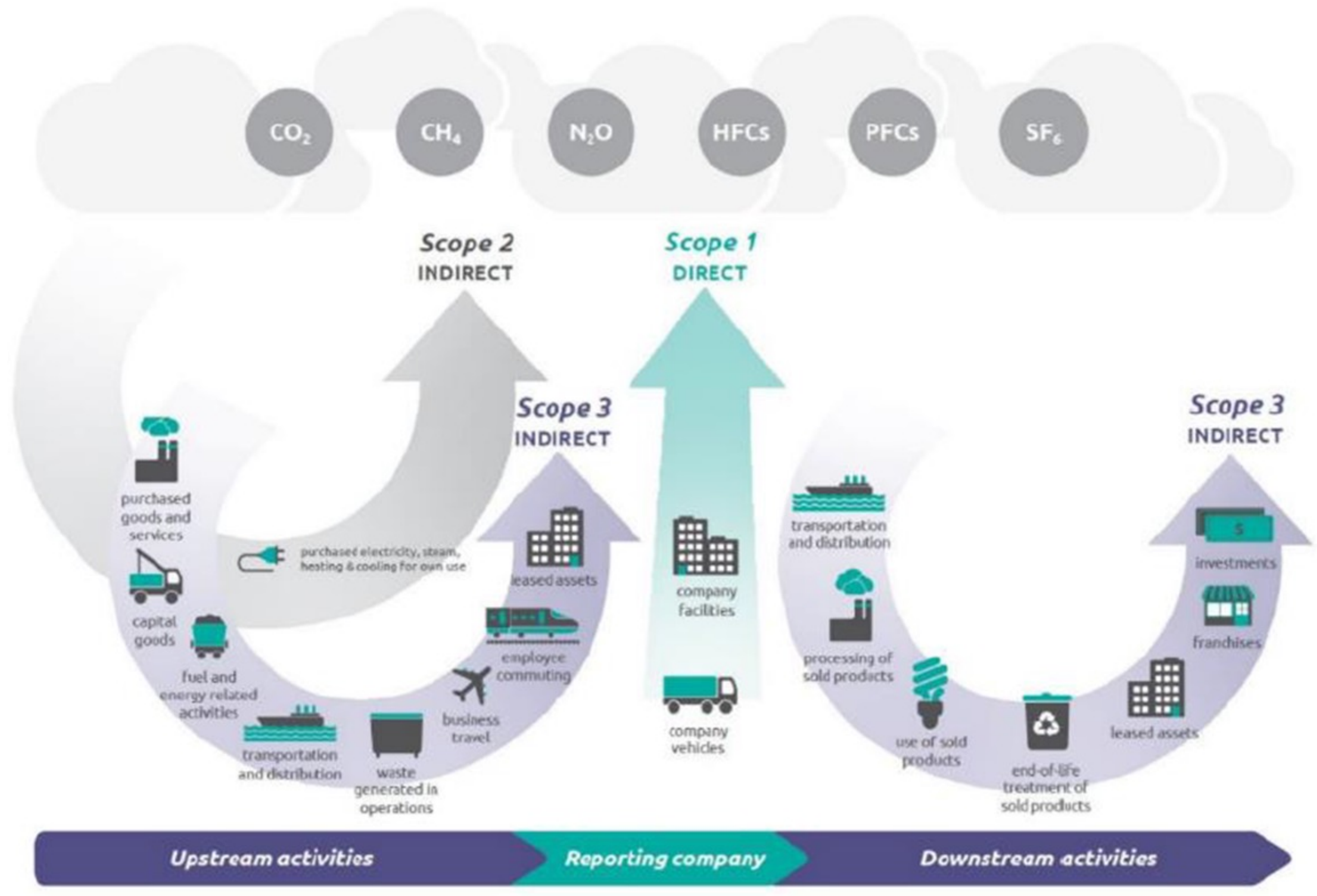

Figure 3.10: Classification of methane emissions into scopes

3.2.3 Types of emission

Methane emissions are typically classified into four categories:

- point emissions - due to discharges into the atmosphere due to or intentional releases for planned or extraordinary mechanical maintenance operations of components or parts of the plant:
  - Intentional releases for interventions on the network in operation such as new connections, increases, replacement of sections of pipeline, pig crossings, etc.)
  - Intentional release of pipeline sections Unintentional releases, typically
  - caused by accidental pipeline ruptures
- fugitive emissions - due to leakage from seals (e.g. valve stems, flanges, connections, safety valve bodies) and leakage from open-ended lines, i.e. valve seats one side of which is in contact with the atmosphere
- pneumatic emissions - from control equipment (e.g. valves operated by means of compressed gas discharge) and from gas analysis equipment (e.g. gas chromatographs, hydrometers, analysers)
- emissions from incomplete combustion - due to incomplete combustion of the burned gas (e.g. in gas turbines, gas preheating plants).

These definitions are not completely unambiguous and there is not yet a single taxonomy that is adopted across all sectors; different classifications adopted by different associations or working groups dealing with methane emissions can be found.
The European Technical Committee CEN/TC 234 "Gas infrastructure", for example, activated in late 2020 a working group to define, at European level, a technical document for Fpr CEN/TS "Gas infrastructure - Methodology for methane emissions quantification for gas transmission, and distribution systems, underground gas storage and LNG terminals". The definitions related to significant fugitive and venting emissions reported in the above document are:

- **methane emission:** release of methane to the atmosphere, whatever the origin, reason and duration

- **fugitive emission**: leakages due to tightness failure and permeation
  incidental emission: methane emissions from unplanned events (this will be from failures of the system due to third party activity, external factors, corrosion, etc.)
- **incomplete combustion emissions:** unburned methane in the exhaust gases from natural gas combustion devices, such as turbines, engines, boilers or flares
- **operational emission:** methane emissions from normal or planned operating activities (this includes release through stacks; blow off valves, pressure release and purging of turbines and emissions due to normal maintenance inspection and control. Operational vents comprise planned venting and purging of pipelines, which is usually done during commissioning, decommissioning, renewal and maintenance of pipelines for safety reasons to prevent the risk of explosions. Pneumatic emissions are also operational emissions)
- **permeation:** penetration of a permeate (such as a liquid, gas, or vapour) through a solid (in case of natural gas through pipelines made of polymer materials, it is directly related to the pressure of the gas, intrinsic permeability of polymer materials and wall thickness. Polymers can be polyethylene, polyamide or PVC)
- **pneumatic emission**: emissions caused by gas operated valves, continuous as well as intermittent emissions
- **vented emissions:** gas released into the atmosphere intentionally from processes or activities that are designed to do it, or unintentionally when equipment malfunctions or operations are not normal (in the case of transmission and distribution grids, unintentional vented emissions during not normal operation also cover vents due to external interference [third-party damage], ground movements, over-pressure, etc.).

Oil and Gas Methane Partnership 2.0 defines five different emission categories for Upstream and three categories for Midstream and Downstream:

- emission categories for upstream
  - Venting (i.e. planned releases of gas to the atmosphere as a result of process design)
  - Fugitive losses (i.e. unintentional releases to the atmosphere resulting from leaking equipment)
  - Flaring (i.e. the unburned fraction)
  - Energy / Combustion (i.e. the unburned fraction)
  - Other / Unspecified (i.e. for emission events or sources which do not align with one of the other 4 categories)
- emission categories for mid- and down-stream
  - Fugitive losses
    - Leaks from connections
    - Tightness failure
    - Permeation
  - Venting
    - Operational emissions: Purging/venting for works, commissioning and decommissioning; Regular emissions of technical devices; Starts & stops
    - Incidents
  - Incomplete combustion

3.3 OTHER CLIMATE-CHANGING EMISSIONS

Greenhouse gases are not all the same when it comes to the Global Warming Potential (GWP), which expresses the contribution to the greenhouse effect of a gas relative to the effect of CO_2, whose reference potential is 1. Methane, CH_4, one of the other most important atmospheric GHGs, has a GWP of about 30 referred to 100 years. Among GHGs, sulfur hexafluoride (SF_6), although relatively rare in the atmosphere, has a GWP of 23,500 and is the most potent GHG. It is an odorless, non-toxic, and highly stable gas used in a variety of industrial and scientific applications, including as a propellant and insulator. Most SF6 is used in the electrical industry as a dielectric medium providing a high performing, safe and cost-effective solution for electrical insulation and power interruption.

Providing sustainable alternatives to SF6 and other GHGs in industrial use and production is an important approach to overall GHG management. Worldwide, regulations are increasingly targeting SF6 emissions because of their impact on GWP. For example, SF6 has already been banned in the EU, with the exception of the electricity sector where few suitable alternatives are available.

Electrical equipment manufacturers are working to find SF6-solution free to accelerate the adoption of greener technologies.
For example, there are now SF6-alternative free for medium voltage switchgears, which is a significant contribution in the right direction in the fight against global warming.

4 POLICIES AND REGULATIONS

4.1 INTERNATIONAL POLICIES, ACTIVITIES AND WORKING GROUPS

In recent years, both at European and international level, medium and long-term policies and objectives aimed at reducing emissions and achieving carbon neutrality by 2050 have multiplied, assigning a central role to the world of energy.

In particular, in 2019, the European Union approved the "European Green Deal", which encapsulates initiatives in line with the objectives presented in the two 2018 packages: the "Clean Energy for all Europeans" to 2030 and the "EU 2050 Climate Long-Term Strategy", in order to make Europe the first continent to achieve climate neutrality by 2050 and with the objective of limiting the increase in global warming to keep it within the limits set by the 2015 Paris Agreements. In 2021, a new package, the "Fit for 55", was added as part of the Green Deal, reinforcing the target to reduce carbon dioxide emissions to 55% by 2030 compared to 1990 levels, demonstrating the growing institutional commitment to addressing climate-related problems and limiting global warming.

To support the 2030 and 2050 targets, the European Commission presented on December 16, 2021, a draft European regulation on reducing methane emissions in the energy sector, which is very prescriptive, with very binding rules on monitoring, reporting, verification, detection and mitigation of emissions. At the 26th United Nations Climate Change Conference (COP26) in Glasgow in November 2021, the United States and the European Union also agreed to officially launch the Global Methane Pledge, anticipated by the US and EU at the September 2021 Major Economies Forum (MEF) meeting. Participants joining the Pledge agree to take voluntary actions to contribute to a collective effort to reduce global methane emissions by at least 30% from 2020 levels by 2030, which could reduce warming by more than 0.2°C by 2050. Currently more than 100 countries accounting for 70% of the global economy and nearly half of anthropogenic methane emissions, including Italy, have agreed to make such a commitment.

For several years, the Oil & Gas industry has been particularly active in defining and disseminating policies, technical documents and guidelines on the topic of reducing and reporting methane emissions, through trade Associations, technical standardization bodies, voluntary partnerships between supply chain operators and other stakeholders, in Italy and at European and international level. These activities, in addition to the preparation of common policies and strategies and technical reference documents, are also essential to promote the exchange of best practices and the dissemination of knowledge among operators in order to build a culture oriented to minimizing emissions, and to relate in a coordinated and organic way to institutions and other stakeholders.

Some of the main activities in this area, in which operators in the sector are actively involved, are outlined below.

The European Gas Industry Technical Association MARCOGAZ [www.marcogaz.org] and **Gas Infrastructure Europe** - GIE Europe [https://www.gie.eu] are associations particularly active on issues related to climate change and methane emissions.

In particular, MARCOGAZ deals with all technical aspects of the entire gas system value chain, promoting innovation and monitoring technological solutions to detect, quantify, report and mitigate methane emissions due to Transmission, Storage, LNG and Distribution activities. MARCOGAZ has developed a methodology for quantifying and reporting methane emissions, which has been an important reference for the gas industry for years. These are the main publications of MARCOGAZ and/or GIE on the subject:

- MARCOGAZ methane emissions reporting template
- guidance for the MARCOGAZ methane emissions reporting template - TSO-UGS-LNG receiving terminals-DSO
- potential ways the Gas Industry can contribute to the reduction of CH_4;
- recommendations on Venting and Flaring;
- recommendation on LDAR campaign;
- Methane Emissions Glossay;
- guidelines - Methane Emissions target setting ;
- assessment of methane emissions for Gas Transmission & Distribution System Operators;
- Methane Emissions in the European Natural Gas midstream sectors;
- survey Methane Emissions for Underground Gas Storage (UGS) facilities in Europe;
- survey Methane Emissions for LNG Terminals in Europe;
- survey Methane Emissions for Gas Distribution in Europe.

All the documents published by MARCOGAZ can be downloaded from the Association's website.

Through MARCOGAZ, European transport and distribution companies also participated in 2021 in the consultation process related to the Methane Strategy announced by the European Commission in late 2020, in view of the legislative proposal on methane emissions, then published in late 2021.

The Oil & Gas Methane Partnership (OGMP [8]) is a voluntary initiative by the Oil & Gas industry to reduce methane emissions, together with a number of Institutions, led by the United Nations Environment Programme (UNEP). 76 companies with assets on five continents, representing 30% of the world's oil and gas production, have currently joined the partnership. OGMP provides a protocol to help companies systematically and transparently manage their methane emissions. This protocol has been updated to encourage better performance in both reporting and reducing methane emissions through transparency, flexibility, collaboration and sharing of best practices. The most virtuous companies that achieve the highest levels of accuracy required and the stated reduction targets will be awarded the so-called Gold Standard. Based on this protocol, a proposal for a European Regulation on methane emissions was drafted and published by the European Commission at the end of 2019.

A series of technical documents and detailed guidelines for the reporting and quantification of the various types of emissions are currently being prepared by OGMP through special task forces. The report on the implementation of the first year of the protocol in version 2.0 ("An Eye on Methane: International Methane Emissions Observatory 2021 Report") is available on the UNEP website [10] and shows the level of accuracy of the participants' data, their reduction targets and their declared action plan to achieve the Gold Standard.

On the basis of the methodology developed by MARCOGAZ, CEN - European Committee for Standardization, through the WG 14 "Methane Emissions" of the Technical Committee TC 234 "Gas Infrastructures", since the end of 2020 has activated the work to define a standard for a "Methodology for the quantification of methane emissions from transport, distribution, storage and LNG terminals infrastructures".

The standard, currently in a very advanced draft, has been drawn up with the fundamental contribution of the supply chain operators and can be used to comply with the reporting standards set out in the OGMP 2.0 Framework.

The European Gas Research Group (GERG) works with the European energy community to develop innovative solutions that put gas infrastructure at the heart of the energy system. In this context, GERG, with the participation of the main European gas infrastructure operators and industry associations, has launched a research project aimed at improving the knowledge and use of top-down technologies (using instrumentation mounted on satellites, drones, aircraft or other means to measure emissions at site level) to quantify methane emissions in midstream infrastructure. The initiative is intended to support the strategy of European energy companies to achieve the Gold Standard of the OGMP 2.0 protocol, and is in line with the European Commission's proposed legislation to make these techniques mandatory in the coming years. This work will demonstrate the efforts that the midstream gas sector is making to improve the quantification of its methane emissions.

The MGP - Methane Guiding Principles group [11] is a partnership between Oil & Gas operators, along the entire value chain, and non-industrial organizations / research bodies / NGOs, whose participants commit to the following guiding principles:

- continuously reduce methane emissions
- promote high performance along the value chain
- improve the accuracy of methane emission data
- Promote appropriate policies and regulations on methane emissions
- increase transparency.

The group's various activities include the publication of guidelines on best practices for quantifying and reducing methane emissions, which can be downloaded from the MGP website [12].

The International Gas Union - IGU [13] has set up a Group of Experts on Methane Emissions (GEME), which is responsible for keeping the various players in the gas chain up to date with the latest news emerging at a global level.

Gas Naturally [14] is a partnership between eight associations representing the EU gas chain: Eurogas, GERG, GIE, IOGP, IGU, Liquid Gas Europe, Marcogaz and NGVA. Some relevant documents have been published in the course of 2020 such as "Reducing the GHG footprint of the gas value chain: progress in methane emissions management and reduction" in collaboration with Euractiv, the feedback on the EU Methane Emissions Strategy Roadmap, the "Gas industry Declaration on the EU strategy to reduce methane emissions" as co-signatory between several European Associations.

The Environmental Partnership Oil & Gas [15] committed on a voluntary basis to improving its environmental performance.
The goal of the Environmental Partnership is to continually improve the environmental performance of industry by taking concrete action, adopting best operating practices best technologies, and fostering collaboration to responsibly develop U.S. natural resources.
The partnership was formed in 2017 and the number of Companies that have joined the program has grown from the initial 23 to nearly one hundred as of April 2022 [16].
The Environmental Partnership has a focus on solutions that are technically feasible, commercially proven and can make a significant contribution to reducing emissions, providing a platform for sharing information and analyzing best practices and technological innovations, with the ultimate goal of improving awareness of emissions and how they can be reduced.
The partnership has developed six separate programs, relating to:
- Leak Detection and Repair
- Flare Management
- Pipeline Blowdown
- Compressor
- Pneumatic Controller
- Manual liquids unloading.

The Environmental Partnership publishes an annual report [17] summarizing its findings. The Environmental Partnership is also linked to the American Petroleum Institute's (API) Climate Action Framework, which has set out an industry action plan on:

- Acceleration of technological development and innovation
- Further reduction of operational emissions
- Adoption of a Carbon Price policy
- Development of advanced clean fuels
- Transparent reporting of climate-changing emissions.

Related to the second point, API supports cost-effective policies and direct regulation that achieve methane emission reductions from new and existing sources along the supply chain and supports the development and deployment of new technologies and practices through industry initiatives such as the Environmental Partnership to better understand, detect, and mitigate emissions.

The International Association of Oil & Gas Producers (IOGP) [18] is an authoritative voice of the oil and gas industry, with 83 members who collectively produce 40% of global oil and gas resources. Its members include Eni and Shell. The association runs a series of initiatives on various industry-related issues, including sustainability issues such as Gas Naturally.

The Oil and Gas Climate Initiative (OGCI) [19] has launched the Aiming for zero methane emissions Initiative, with the ambition of zero methane emissions by 2030, and is continuing its efforts to optimise its monitoring and reporting processes for the reduction of methane emissions from operated assets. At the OGCI level, numerous projects are underway for the study, development and testing of new technologies, with particular reference to the detection and mitigation of methane emissions [20].
On December 6th, 2022, Assorisorse adhered to OGCI Aiming for Zero Methane Emissions initiative.

4.2 THE ITALIAN REGULATORY FRAMEWORK

In Italy, there is no specific legislation limiting methane emissions; in particular, they are not subject to the limits of Legislative Decree no. 155/2010, relating to ambient air quality. At the national level, the following main regulatory references can be cited:

- **CIG - Comitato Italiano Gas** [21], a body federated to UNI, participates to MARCOGAZ and CEN/TC 234 works and has already activated a series of working groups for the adaptation of technical standards according to national and European norms and regulations
- **ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale,** in accordance with the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the European Union's Greenhouse Gas Monitoring Mechanism, collects and processes data from the National Inventory Report (NIR), including methane emissions
- **Regulatory Authority for Energy, Networks and the Environment (ARERA),** which is responsible for regulating the infrastructures of the natural gas system, has for some years now issued provisions aimed at reducing methane emissions in the areas under its jurisdiction. As far as the gas transmission sector is concerned, ARERA has adopted, within the regulation for the determination of transmission service tariffs, a mechanism for recognising the costs of network losses based on standard criteria, in order to create an incentive for the containment of these emissions. In
- addition, within the regulation for the quality of transport and distribution service, ARERA has introduced a requirement to inspect networks for leakage.

Also at the national level, in 2021 some Oil & Gas operators, together with relevant Institutions, Associations and suppliers, involved in the issue, have contributed to the preparation and signed a document of "Guidelines for an Italian strategy on methane emissions of the natural gas supply chain", written by the environmentalist **Association Amici della Terra**, in collaboration with **EDF - Environmental Defense Fund**, with the aim of encouraging an active participation of Italy in the stages of the legislative process of the European Green Deal, starting from the definition of the European regulation on methane emissions. **On December 21st, 2022, Amici della Terra and EDF issued an updated strategy document, in cooperation with key industry players and associations, including Assorisorse.**

4.3 REGULATION AND BUSINESS PROPOSALS

The energy sector sees the minimization of methane emissions as an opportunity to actively contribute to climate change mitigation in the short term, accelerate environmental commitments and further improve the environmental value of natural gas and its infrastructure, bearing in mind that natural gas will be a key resource for managing the energy transition. In this phase, in fact, gas is able, on the one hand, to provide the services of flexibility, security and diversification of energy supply sources and, on the other hand, to support a path towards a low-carbon economy at the lowest overall cost for the system, thanks to the availability of an infrastructure network already in place and widespread, such as the Italian one, and at the same time promote the decarbonization of the same gas carrier through the development of renewable gases such as biomethane, hydrogen and synthetic gas.
The gas industry therefore welcomes possible European legislation to reduce methane emissions, covering not only the power sector, but also agriculture and waste with the aim of having an inclusive approach to

methane and best exploiting synergies between sectors (e.g. injection of biomethane - produced from manure and waste - into European gas grids) thus helping to avoid emissions in other sectors.
The gas industry has worked successfully for many years to reduce methane emissions through mainly voluntary programs and remains firmly committed to taking even stronger action to further reduce methane emissions along the entire gas value chain. The industry therefore supports the implementation of appropriate and cost-effective methane mitigation tools that take into account, among other things, the following principles and elements to achieve effective reduction targets:

- **flexibility** is essential for the industry to implement the tools and technologies already available that will allow the maximum reduction of emissions at the lowest cost and in the shortest possible time. For example, it is necessary for technical regulations to recognize the specificities of the various segments of the supply chain. The upstream sector is characterized by a relatively limited number of large, concentrated plants, while in the transport and distribution sector there are thousands of small plants scattered throughout the territory: it is therefore appropriate for the implementation of technical regulations, such as LDAR, to take these specificities into account
- **a well-structured MRV** (Monitoring, Reporting and Verification) system shared by all operators will be fundamental for a more accurate quantification of methane emissions along the gas chain and will allow a better comparison and evaluation of the results of the mitigation measures in place. In this respect, the OGMP 2.0 Framework appears to be the most appropriate reference for operators today. This will also allow an improvement in the quality of the data of the National Inventory Report (NIR [22]), prepared by ISPRA. It should be noted that, for some parts of the gas infrastructure, there is significant room for improvement in data quality
- it is necessary that the **costs and investments** undertaken by infrastructure operators for the reduction of methane emissions are recognized by the Regulatory Authorities within regulated activities, through the tariff system, since infrastructure operators do not own the gas. In the case of non-regulated operators, costs and investments should be supported through European and national incentives
- **industry is willing to support legislators** in exploring the feasibility and added value of possible performance targets
- **innovation, development, improvement**, and implementation of appropriately targeted technologies and practices to improve reporting and mitigate emissions are the basis for effective methane emission reductions. Therefore, these technologies and practices should be further supported
- **Co-operation with non-EU countries** should be encouraged as it is essential to address the reduction of methane emissions along the chain of gas imported into the EU

4.3.1 Feedback on the regulatory proposal

On 17 April 2022, the Working Group provided its feedback on the proposed European regulation on methane emissions shown in the figure below. The feedback provided is in line with that provided by other national and international bodies, such as ENTSOG, Eurogas, GERG, GIE and MARCOGAZ, with which Assorisorse collaborates to create synergies that favor the adoption of operational solutions and the development of common strategies.

METHANE EMISSIONS REDUCTION

ASSORISORSE
Risorse Naturali ed Energie sostenibili

Feedback to the Proposal for a regulation of the European Parliament and of the Council on methane emissions reduction in the energy sector and amending Regulation (EU) 2019/942

Assorisorse represents about 100 companies that employ over 120.000 employees in Italy and abroad, covering most industrial sectors. **We are committed to supporting public decision makers and key stakeholders and we are engaged in constant monitoring and proposal action relating to legislative and regulatory activity.**

The working group on methane emissions has been established in 2021 to intercept the need to significantly reduce emissions into the atmosphere, whatever the origin, reason, and duration. The whole methane value chain is represented: technology providers, engineering and EPC contractors, operators, testing, inspection and certification bodies, and consultants.

Assorisorse collaborates with national and international bodies to create synergies that favor business operations and the development of common strategies: our comments, reported below, are aligned with those of ENTSOG, Eurogas, GERG, GIE, and MARCOGAZ.

Assorisorse members are committed to reduce methane emissions and support the deployment of a sound and effective roadmap.

Here are our recommendations for the Regulation:

- To make costs and investments efficient, industrial companies, not limited to gas companies, in close dialogue with the Competent Authorities, should define a methane emissions mitigation **plan**, which will allow **prioritisation** of the most cost-effective **mitigation measures**
- We welcome the proposal about the **recognition of investments** and operating **costs** incurred by regulated operators. The compensation of investments and efforts of non-regulated operators should also be promoted and guaranteed through incentives
- New requirements for **verifiers** and on **inspections** should be aligned with current obligations and practices to avoid unnecessary costs and administrative burden
- **One type of solution does not fit all cases.** The principle of **proportionality** should be considered, avoiding obligating high-cost measures for end-users and society with little or no mitigation effect. **Also, flexibility** is needed to **prioritise actions** to ensure that the optimal **cost-effective** approach is applied
- **Monitoring, Reporting and Verification (MRV):** We recommend **aligning** the MRV system with the ambitious **OGMP 2.0** reporting standard, considering the reporting framework and template and the technical guidance documents as well as key concepts and requirements (such as materiality, representative sampling)

  However, due to the **low maturity of site-level methodologies and technologies**, we recommend postponing the inclusion of obligations on quantification with them to when the relevant technologies will be mature

  We recommend that the EC launches a **mandate to CEN to standardise quantification, reporting, potential comparison methods and uncertainty calculation** based on OGMP 2.0

  The Regulation should refer to **"quantification"** instead of to **"measurements"**, as engineering calculations and emission factors should be considered for reporting

  Double reporting should be avoided; hence we propose:

  - To align the new reporting obligations with the current ones (e.g., NIR)
  - Reporting of non-operated assets to be done only by the asset operator
  - New reporting responsibilities on LDAR and venting and flaring to be done on an annual basis as part of the emissions reporting
- **Leak Detection and Repair (LDAR)** should allow for **the different practices successfully used by the operators, as they are adapted to the different parts across the value chain**

  To optimise efforts, we recommend **not to define intervals for LDAR surveys but rather define them in the LDAR programme submitted to the Competent Authorities**

  Immediate repairs shall be carried out whenever possible, but the regulation **must allow adequate repair times that respect the technical, safety, environmental and administrative constraints**

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We recommend developing a **CEN standard on LDAR methodologies**, including scope of the survey depending on operators, programme and repair or replacement criteria

- It is important to ensure a **lead time** for implementing the **venting and flaring** provisions and **grant an exemption** when venting is leading to **non-material emissions**
- The definition of **inactive wells** lacks accuracy and needs to be improved such that permanently plugged wells are excluded from the definition to avoid incurring unnecessary and significant cost
- EU importers cannot be held liable for elements outside their control or outside the EU's jurisdiction. The responsibility for the data quality of the **methane emissions occurring outside the Union** should remain with the exporter

Rome, April 17th, 2022

Figure 4.1: Feedback to the Commission on the regulatory proposal

5 BEST DESIGN PRACTICES

5.1 INTRODUCTION

5.1.1 Purpose

The purpose of this section is to provide information on what has been done and what can be done in the field of Oil & Gas design by sharing guidelines, projects and development initiatives currently in place and planned.
The issue of methane emission reduction in plants can be addressed through various modalities and in a very significant way during different phases of the design activity, involving various disciplines, from the elaboration of the FEED (Front End Engineering Design) to the Detail Engineering, to the preparation of operating and maintenance manuals of the plant up to the elaboration of Commissioning and Start Up procedures. In this chapter, particular emphasis will also be given to the distinction of activities involving the design of plants on Greenfield or Brownfield.

5.1.2 Context

Appropriate design choices make it possible to achieve significant reductions in methane emissions or even to pursue the goal of zero emissions.
It should be noted that the choices that make it possible to move towards a significant reduction in emissions often have different time and cost impacts. Some solutions, with low impact, require only to be identified in time in the early stages of the project and to be placed among the objectives to be pursued, while other solutions involve significant impacts on costs and time compared to the low cost technical solutions commonly adopted and often consolidated by experience.
The latter solutions, sometimes among the most effective, cannot depend solely on the Contractor's initiative but must necessarily be made their own by the Owner and be written into the project specifications.
Often this happens in compliance with developments in the regulatory framework that imposes obligations or makes remunerative some "virtuous" technical choices. See for example the recent Proposal for European Regulation of 15 December 2021 and the pre-existing regulatory framework for which please refer to Chapter 4 of this document.
From multiple experiences, a factor that sometimes hinders possible interesting technological developments is the inertia to change that favors the choice of known solutions, or already used in the same plant, but obsolete, instead of more advanced and better performing solutions.
The reasons for this attitude are:

- The Customer's in-depth knowledge of the features, pros and cons of the technologies used for a long time
- Slow implementation of best practices by some operators
- Easier management of spare parts and stock management in case there are other identical systems in the plant

The Contractor can play an important role as a consultant proposing the most advanced technologies and presenting technical analysis or promoting meetings with suppliers in order to update the customer on the state of the art of technology, especially in non-European or developing countries.

5.1.3 Types of intervention

It should be noted that there are different approaches depending on whether the work involves Greenfield plants, i.e. plants built as part of a new project, or Brownfield plants where Debottlenecking, Revamping or Expansion work is carried out.
In the first case (Greenfields), greater flexibility and greater freedom in the choice of solutions is allowed, but at the same time often places more stringent constraints from a legislative point of view in the case of newly built plants.
Debottlenecking or Retrofitting or expansion of existing plants (Brownfields) are generally more challenging both from a design and organizational point of view, as the proposed solutions must be harmonized with the pre-existing plant and pose precise technical and space constraints.
Construction work poses particularly challenging safety problems because excavation, vehicle handling and material transport activities must be carried out inside running plants.
In many cases, tie-in and commissioning activities are carried out within restricted shutdown windows of the entire plant and therefore require a high level of organizational effort in the coordination of the different teams, which must necessarily work in parallel in an efficient and, above all, safe manner. In the two types of activities, the objective of reducing or eliminating emissions is pursued according to different approaches that will be analyzed in the following sections.
These interventions present an extreme variability both with regard to the technology, the typology and consequently the complexity of the intervention, and on the basis of the different potentialities of the plants on which the intervention is carried out. All this has important reflections on costs and implementation times.
Figure 5.1 and Figure 5.2 provide a qualitative assessment of the ranges of costs (CAPEX) and timescales for carrying out a series of interventions on Oil & Gas plants.

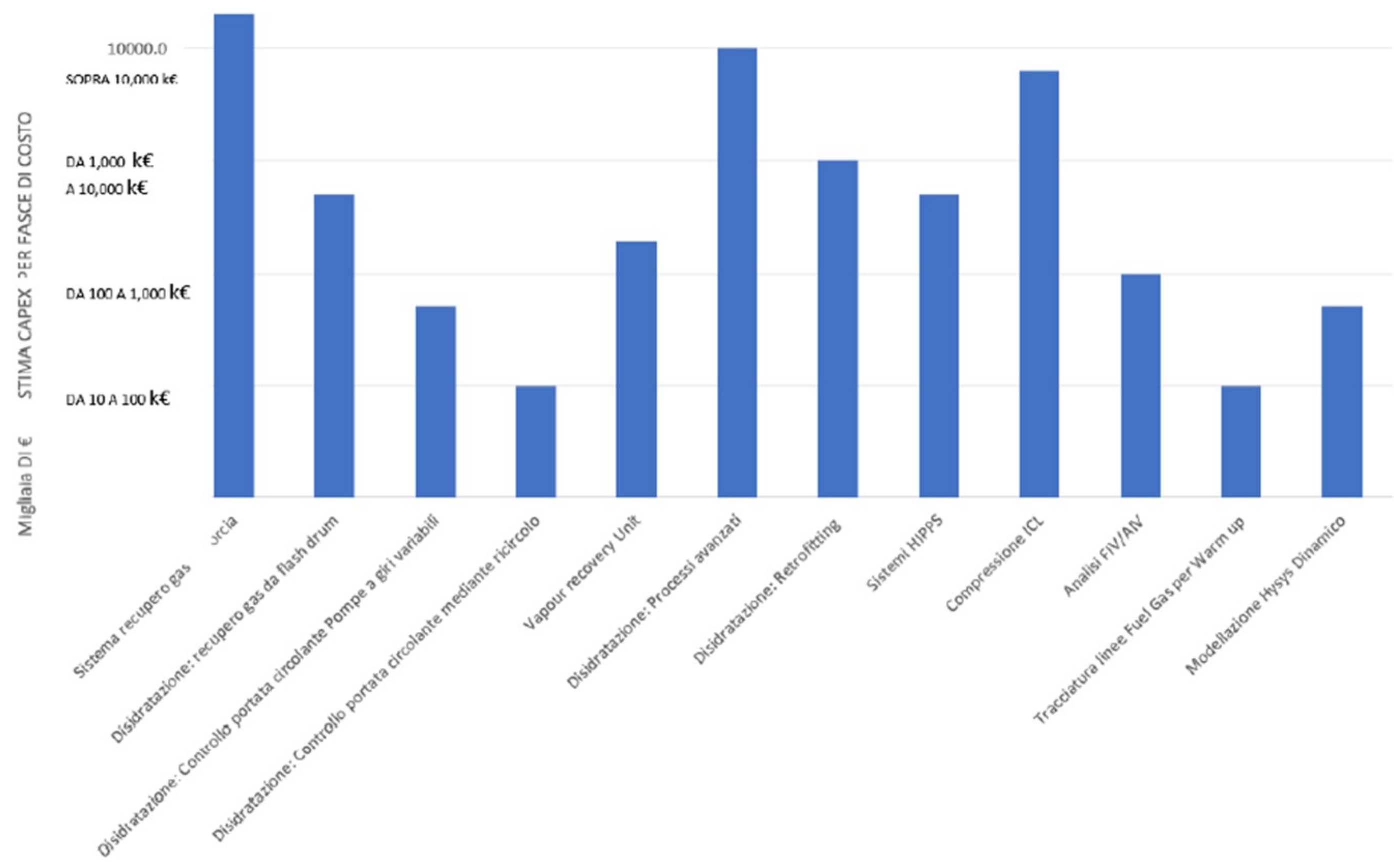


Figure 5.1: Typical CAPEX estimation by type of intervention

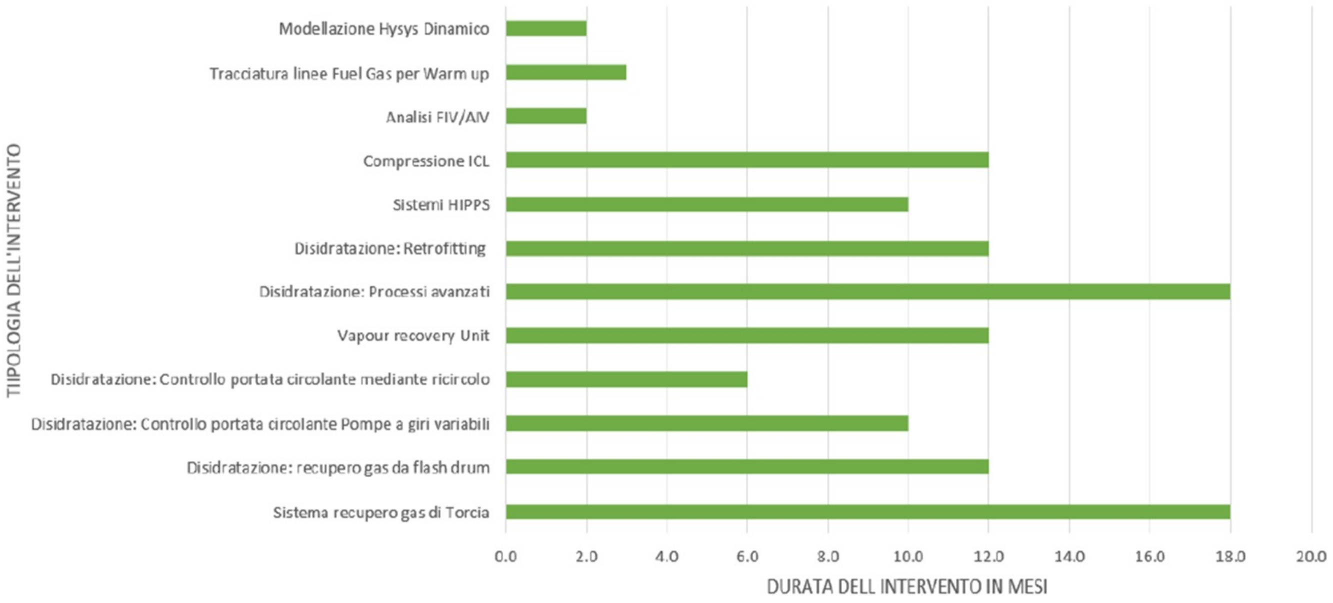


Figure 5.2: Estimate of typical times by type of intervention

5.2 PROCESS

Given the complexity and the large number of processes used in industry, it is almost impossible to provide a complete and detailed picture of all the process strategies that can be implemented to minimise methane emissions.

Having said this, in the following sections we will limit ourselves to indicating, limited to the Oil & Gas sector and the main unitary operations, some of the main expedients that can be implemented to achieve significant results.

The GOSP (Gas Oil Separation Plant) is a plant in the Midstream sector that receives crude oil from the Trunklines and Flowlines of neighboring wells and separates the crude oil into the three phases (oil, gas, water). The function of the GOSP is to separate and treat oil, gas and water and process the different streams from the wells into products that are safe to handle and marketable.

Downstream of the gathering manifold and facilities such as traps and Slug Catcher are the three-phase separators from which the three oil, gas and production water treatment lines originate, the flare exhaust collection system, utilities such as the fuel gas system and open and closed drains.

Each of these elements can be properly analyzed to identify alternative solutions to minimize discharges to the atmosphere.

A number of solutions / approaches is discussed in the full report, namely:

- Flare gas recovery → **see Focus box**
- Multistage separation with gas recovery and recompression
- Gas dehydration
- Re-injection water treatment
- HIPPS systems
- Choice of design pressure
- Shutdown philosophy

5.3 MACHINES and EQUIPMENT

In the set of solutions for the reduction and containment of methane emissions in the Oil&Gas services, and elsewhere, there are new technologies of great interest.

As before, a number of solutions/approaches is discussed in the full report, namely:

- Integrated Compression Line (ICL)
- Turbocharger warm-up system
- Piping Engineering
- Measures to be taken during installation

5.5 PRECOMMISSIONING AND COMMISSIONING

The main purpose of the commissioning activity is the execution of functional tests prior to the start-up of a new plant. The accurate execution of such tests (supported by adequate procedures) to be carried out before the hydrocarbons are allowed to enter the plant (cold commissioning) is a guarantee of a start-up in which the possibility of spurious, unexpected blockages and gas releases is minimized.

METHANE EMISSIONS REDUCTION

Among commissioning operations, a distinction is often made between cold commissioning operations (i.e. tests without the presence of hydrocarbons, or blank tests with inert fluids) and hot commissioning, i.e. those functional tests that require the presence of the process fluid (e.g. functional tests of anti-surge valves).

Especially in the case of hot commissioning tests it is advisable to develop the relevant commissioning procedures indicating a target for gas consumption during the hot commissioning and start-up phases.

It is advisable that the commissioning procedures are developed in advance with the integrated support of the commissioning team and engineering in order to be able to include, already in the design phase, such expedients as to allow the best execution of the tests (e.g. field instrumentation or dedicated detachments), setting among the objectives to be achieved that of minimizing emissions.

It is particularly important to develop accurate leak detection procedures that are easy to understand and execute with the aid, where possible, of screenshots from the 3D model illustrating valve positions, points to be checked, flanges to connect to, etc., as shown in Figure 5.15 below. The correct execution of leak tests minimizes the possibility of gas leaks during start-up.

5.6 START-UP - DYNAMIC MODEL

A particularly useful and effective tool for preventing or at least minimizing upsets during start-ups is dynamic process modeling (e.g. Dynamic Hysys).

The aim is to be able to foresee anomalous conditions such as to cause an emergency discharge in the flare or in the atmosphere due to the intervention of the safety organs and to find the appropriate strategies to avoid such conditions.

With the dynamic modeling it is possible to create a realistic and detailed model of both the process and the plant engineering and control part. It is possible to introduce in the simulation the main parameters responsible for the dynamic behavior of the system, such as:

- Performance curves of pumps and compressors
- Inertial masses of the impellers
- Valve characteristic curves and actuator actuation times
- Volumes of equipment and lines
- PID controllers with characteristic parameters.

In addition, a large number of timed scenarios and events can be defined in order to realistically describe the behavior of the system during transients.

From a dynamic model it is possible to obtain information that is not available from steady state simulation alone (which is fundamental for line and equipment sizing and material balances), ranging from control loop verification to process transient analysis.

To give a practical example, the availability of a dynamic model makes it possible to predict, in the case of a brownfield plant, what impacts the transients of the new plant may have on existing units.

In the event that, under certain conditions, the shutdown of a new unit may cause a domino effect of shutdown on units of the existing plant, with a consequent probable impact on the levels of gas emissions, being able to foresee this in advance, it will be possible to take the necessary precautions by evaluating under what conditions (flow rate, pressure, temperature, number of units in service, etc.) it is possible to test the new units minimizing the risks and the consequent release of gas into the atmosphere.

METHANE EMISSIONS REDUCTION

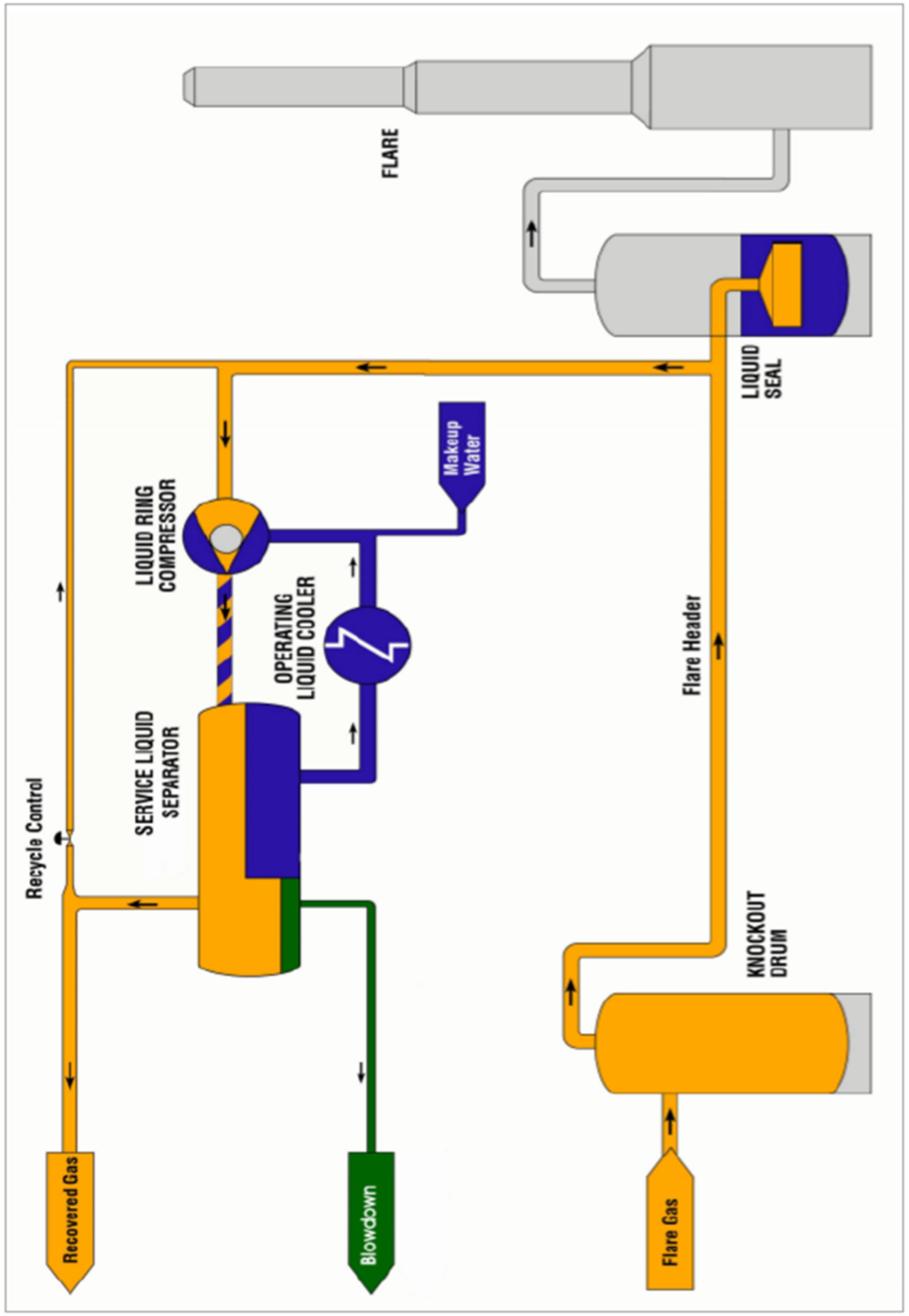
FOCUS: FLARE GAS RECOVERY

Some methods to avoid methane emissions into the atmosphere are:

- interventions aimed at recovering the gas sent to the flare network
- processes to avoid the continuous flare discharge of continuous process gas
- design philosophies to minimize or eliminate emergency scenarios involving large gas quantities.

It should be noted that, while the practice of flaring natural gas into the atmosphere is increasingly rare at an international level, it is not yet consolidated practice, especially in developing countries, to send the continuous process vents to a thermal destroyer to guarantee the absence of hydrocarbons in the fumes. Instead sending the vents to gathering network conveyed to the flare is generally tolerated.
This generates emissions of unburnt hydrocarbons, since the flares are sized and optimized for maximum efficiency at the design flow rates, which are much greater and correspond to emergency discharges.
A possible solution to minimize the amount of gas sent to the flare is to discharge part of the relief gas into a confined space consisting of one or more large parallel pipes (fingers). Subsequently, the gas can be recovered with a small compressor.
Obviously, with a view to a global reduction of emissions and as foreseen by the recent European legislation, it is not only necessary to act on the design and management peactices for the plants located in the more advanced countries, but also to take into consideration the hydrocarbon emissions of the countries from which gas is imported.

DETAILS: Flare gas collection system
A flare gas collection system can be made according to several variants and has the purpose of recovering all the process vents from the low-pressure flare manifold. These vents constitute a small but continuous flow of gas compared to the flare capacity (sized for emergency scenarios) and give rise to the characteristic flame present on the tip of the flare.
The use of a hydraulic seal upstream of the torch stack (see Figure) allows the torch manifold to be kept pressurized up to a pressure value compatible with the process and corresponding to the head of the hydraulic seal (e.g. a 5 m head, approximately equal to 0.5 barg).
Only in the event of an emergency or process upset, the gas pressure will exceed the head and break through the hydraulic seal, reaching the torch. Under normal operating conditions, instead, a compressor or a blower recover the gas contained within the manifold, conveying it back to the process.
These interventions can be carried out on both new ("Greenfield") and existing plants ("Brownfield").



7 BEST OPERATING PRACTICES

7.1 OVERVIEW

Methane emissions in the supply chain show up in different forms, as discussed previously. The objective of reducing methane emissions also requires the improvement of operational practices, through the adoption of the so-called Best Available Technology (BAT) in the O&M field of existing infrastructures, capable of flanking or even surpassing the now consolidated MRV (Monitoring Reporting and Verification) and LDAR (Leak Detection and Repair) approaches.
BAT applies to all points in the methane supply chain, from extraction and processing to transport, storage and distribution, as well as including regasification systems (Figure 7.1).

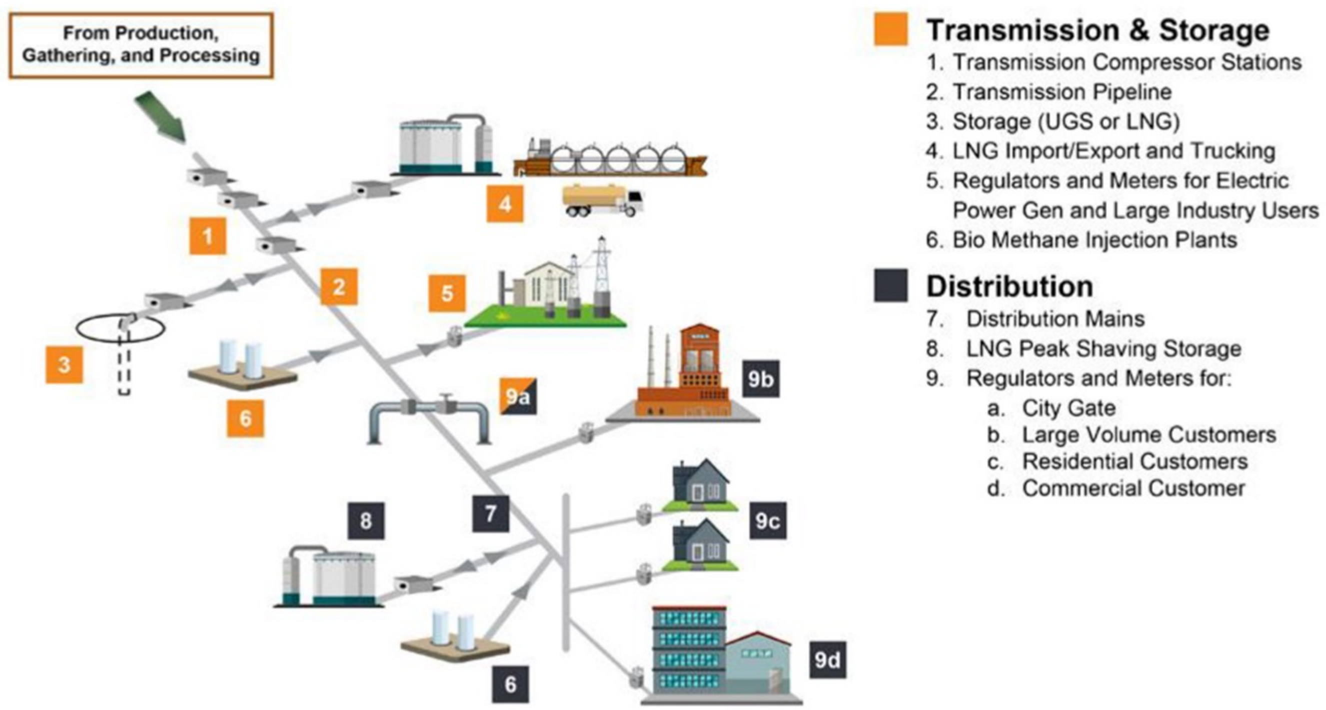


Figure 7.1: Methane supply chain

METHANE EMISSIONS REDUCTION

7.2 MITIGATION MEASURES

The full report lists the main mitigation measures for transport, storage, LNG terminals and distribution activities according to BAT based on the type of emission, structure and source. These techniques are adapted from the September 2020 edition of the Methane Guiding Principles concerning Reducing Methane Emissions: Best Practice Guide Transmission, Storage, LNG Terminals and Distribution.
Furthermore, the report lists some recommendations present in the following European BREFs and national BATs:

- "Emissions from Storage - "5.2.2. Considerations on transfer and handling techniques
- Refining of Mineral Oil and Gas – "4.12.1 Fugitive emissions reduction" e "4.23.6 VOC abatement techniques"
- Cold venting and Fugitive Emissions from Norwegian Offshore Oil and Gas Activities – "Module 3A report
- Best available technique (BAT) assessments" (M-665|2016)
- "Linee guida per l'identificazione delle migliori tecniche disponibili – Categoria IPPC 1.2 – Raffinerie di petrolio e gas"
- Best Available Techniques (BAT) - Reference Document for the Refining of Mineral Oil and Gas
- Best Available Techniques (BAT) - Reference Document for Waste Water and Waste Gas
- Treatment/Management Systems in the Chemical Sector
- Reference Document on Best Available Techniques on Emissions from Storage
- In the following issues of the SPE Italian Section Bulletin, some may be discussed in detail.

7.3 FUGITIVE EMISSIONS AND LDAR ACTIVITY

Fugitive emissions from pressurized equipment and systems used in the methane supply chain are represented by product leaks, usually caused by assembly imperfections or normal wear and tear of joints such as flanged gaskets, threaded connections, valve-stem seals or by the internal failure of the valves one side of which is in contact with the atmosphere, i.e. the so-called open-ended lines.
These also include leaks from the walls of LNG tankers or, in the gas distribution sector, from pressurized pipes due to corrosion or damage to the material.
The first step towards the reduction of fugitive methane emissions is to develop the **Leak Detection And Repair (LDAR)** activity which caters a snapshot of the population of the emission sources. It is divided into the following points (Figure 7.2):

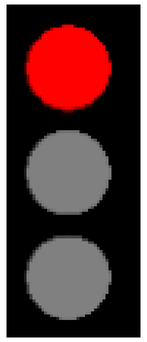
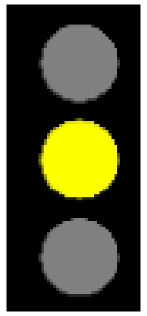
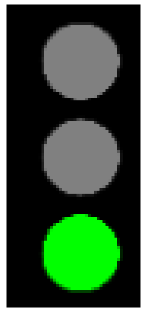
- Master data of the sources
- Source monitoring
- Maintenance of out-of-threshold sources aimed at reducing the emissions value found
- Re-monitoring of leak sources
- Recording of the results and data uploading on specific web platforms or information systems
- Calculation of emissions upstream and downstream of the maintenance intervention.

For a better definition of the LDAR activity, for the midstream and downstream sector reference can be made e.g. to Marcogaz "Leak Detection and Repair - Technical recommendations based on best practices applied by European gas system operators" [24].
The management of "out of range" sources from an engineering point of view intervenes when maintenance fails to bring the source back to tolerability.
The maintenance of the emission sources with intervention and re-monitoring drastically reduces the anomalous sources due to their own fugitive emissions and delivers the so-called bad actors to the environmental improvement intervention of the plants.
The **bad actors** identified by the LDAR technique are the plant objects which, despite carrying out correct maintenance, do not reduce their emission contribution, thus entailing the need to proceed with technological improvement interventions, in particular for the most critical sources (contribution higher than total emissions).
The bad actors must first be identified within the source population and analyzed in terms of improving their ability to contain the process fluid. In this case, BAT and innovative systems come into play that allow "repeat offenders" assets to return to

being objects of maintenance comparable to their counterparts.
In these cases, the consolidated procedure to be developed is the screening indicated in the following Table.
The screening of Bad Actors derives from the intersection of three variables:

- Emission impact
- Cost of technological improvement
- Feasibility of the intervention

More details on this topic are present in the full report.

	**CRITICAL BAD ACTORS** Leak sources to be technologically improved in the short term
	**SUBCRITICAL BAD ACTORS** Leak sources to be technologically improved in the medium term
	**PROGRAMMABLE BAD ACTORS** Leak sources to be technologically improved in the longer term

METHANE EMISSIONS REDUCTION

8 ESTIMATING EMISSIONS

With the increased interest in issues related to the reduction of the carbon footprint and the commitments undertaken at the global level for the containment of emissions related to anthropogenic activities, there has also been a greater attention to the control and consequent reduction of methane emissions, considering the considerable impact of methane as a greenhouse gas. Figure 8.1 shows typical values of methane emissions in the various segments from extraction to distribution to end users. With the continuous change of geopolitical interests linked to the world of fossil sources, it has also been understood the strategic importance of recovering part of the natural gas dispersed in the form of fugitive emissions and from other sources, such as process venting.

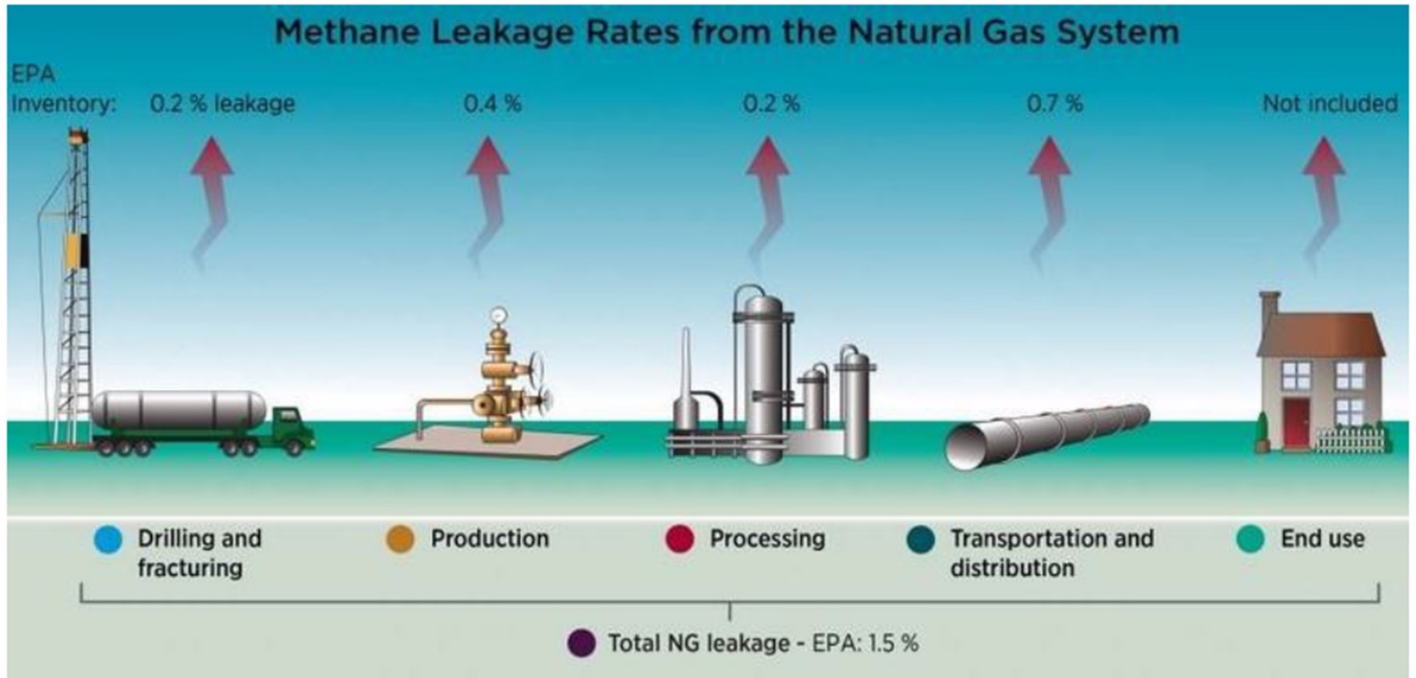


Figure 8.1: Typical values of methane emissions along the supply chain [25]

8.1 STANDARDS AND METHODOLOGIES FOR ESTIMATING EMISSIONS

Over time, techniques and methodologies have been refined allowing us to measure real environmental emissions, implementing monitoring and maintenance plans that are effective in terms of reducing methane gas emissions into the atmosphere.
The main methodologies for estimating fugitive emissions are listed below.

8.1.1 API - Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Natural Gas Industry (2021 edition)

The API Compendium provides emission factors for GHG estimation for natural gas (including distribution systems) and oil industry facilities. The Compendium was updated in 2021 to also include methodologies for LNG and CCUS facilities.
The Compendium also reports the factors for the estimation of emissions for process venting and through a dedicated report it reconciles the uncertainty percentages assigned to the various emission factors (ref. "Addressing Uncertainty in Oil & Natural Gas Industry Greenhouse Gas Inventories: Technical Considerations and Calculation Methods" [26]).

8.1.2 EPA-453/R-95-017 Protocol for Equipment Leak Emission Estimates [27]

To date, US-EPA's guideline for estimating fugitive emissions is the primary reference for implementing “Leak Detection And Repair” (LDAR) programs to identify and reduce fugitive emissions.
The guideline reports four methodologies to approach emission estimation, three of which foresee the use of instrumentation for the field measurement of emissions, in order to have an objective feedback of the actual emissions of the plant. The EPA methodology foresees the creation of a database populated by the various equipment present in the plant, in order to subdivide them by type.

- Average Emission Factor Approach
With this approach, emissions are estimated through the use of EPA emission factors, with a consequent probable overestimation of the real emissions, differently from what would be obtained with a monitoring campaign, due to the need to make conservative assumptions due to the lack of measurements. In order to use the average emission factor approach it is necessary to know the type of fluid in order to be able to associate the respective emission factor for each list of equipment that have been previously catalogued in the database. EPA emission factors are available for the following equipment categories: SOCMI (Synthetic Organic Chemical Manufacturers Industries), oil and gas production, refinery and petroleum marketing terminals.

- Screening Ranges Approach
Compared to the average emission factor approach, this methodology (also known as leak / no leak) requires field measurements to be performed in order to define the respective emission threshold for the various components previously identified and grouped by type. The emission thresholds are higher or lower than 10’000 ppmv.

- EPA Correlation Approach o Values above a threshold usually defined by the full scale of the instrument (also called "Over Range", OR) or definitive based on previous measurement campaigns or Concentration values of zero (no emissions) or Values between the previous two.
This EPA approach is recommended when field monitoring is available, as it provides correlation curves to align measured values with emission rates for the different source categories identified, an example of which is shown in Figure 8.2. The Correlation approach divides the measurements (in terms of ppm concentration) into:
In the three cases, EPA provides correlation tables for the emission factor association even at zero concentration values.

- Unit-Specific Correlation Approach
This last methodology firstly foresees the field measurement of the specific emission sources to be used for their own plant units, through the development of specific correction factors for the reduction of errors in the emission value assignment.

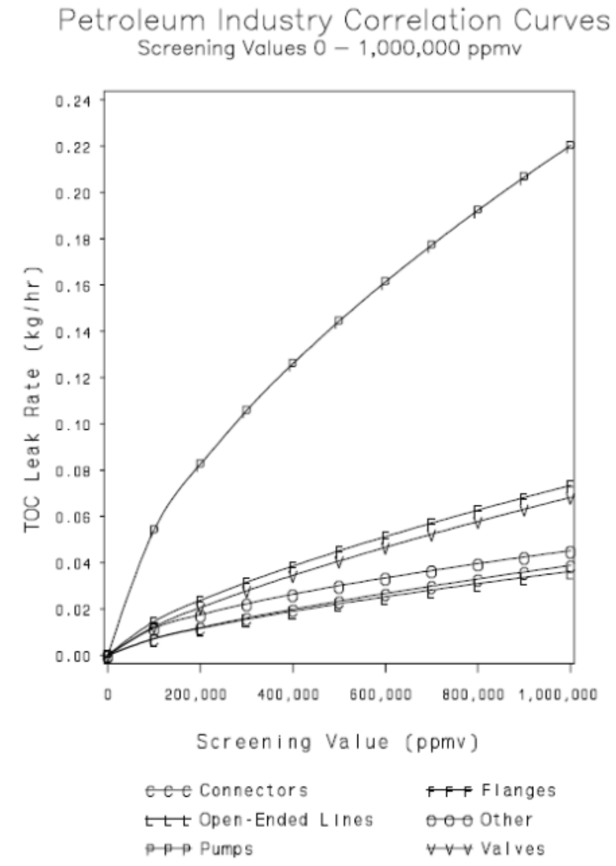


Figure 8.2: Example of a curve for the EPA Correlation Approach [28]

8.1.3 EN 15446 (UNI 15446)

The UNI 15446 standard is the official English version of EN 15446 (January 2008 edition) which adopts EPA Method 21 using FID instrumentation. The standard applies to measurements of fugitive emissions of volatile organic compounds (VOCs) from process equipment. Emission sources include, but are not limited to, valves, flanges and other connections, pressure relief valves, drainage systems, loading valves, pump and compressor seals and gaskets, agitators, and manholes. The standard does not apply to instrument piping connections. In fact in UNI 15446 reference is made to the use of EPA Correlation Approach correlation factors.

8.2 EMISSION SOURCES

The accounting and reduction of fugitive emissions is one of the priorities for the reduction of methane emissions, considering that the emissive sources are also linked to other types of sources such as venting and process emissions, and it passes through the implementation of an LDAR campaign where the emissions from the sources sources identified in the plant are first measured, and then a maintenance campaign is implemented, such as the tightening of the sealing organs in the case of flanged or threaded couplings, to be followed by a subsequent campaign to control the actual reduction of the emission.
The first step in an LDAR campaign can start with identifying potential sources of fugitive emissions.
To this end, starting from the analysis of the P&IDs, the 3D layout and other plant documentation useful for the purpose, a database shall be created to classify and quantify the different types of equipment present in the plant that may give rise to fugitive emissions. Figure 8.3 shows, as an example, what could be the distribution of sources for the main categories of equipment giving rise to methane emissions (such percentages vary depending on the industrial segment considered).

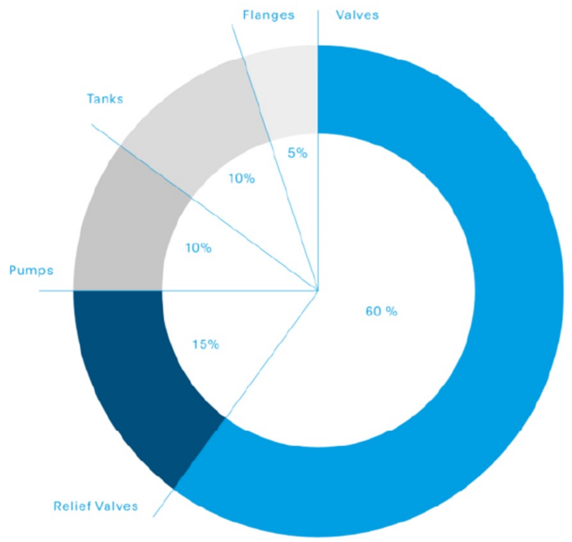


Figure 8.3: Typical distribution of sources by equipment type35

The next step after cataloguing is to identify through a component tag, either by associating it in the database or applying it in the field so as to make the source to be monitored identifiable.
An example of a non-exhaustive list of equipment that can be identified during screening is the following:
- Valves
- Flanged couplings
- Threaded couplings
- Safety valves
- Compressors
- Pumps
- OEL Vents

The main difficulty, once the desktop census is performed, is the accessibility to some of the sources identified for tag application. This impossibility will make the next phase of fugitive emission monitoring inapplicable. In the case in which the source is inaccessible, it will be possible to get around it using the technology that allows, at present, a qualitative analysis of the emission and that employs the OGI camera.
It should be noted that OGI cameras are undergoing advanced studies where through the interpolation of the spectrographic area detected by the camera it will be possible to determine the concentration of methane.
Another difficulty is related to the high number of equipment surveyed, which must be tagged in order to perform the inventory.

Unless there are plant modifications, the census of the emissive sources can last over time and, to this end, it is fundamental to pour this statistical survey on a database to which it is possible to associate the respective plant coding, the associated P&ID associated and, if possible, the geolocalization, so that everything can then flow into a corporate portal, such as a GIS portal, where it can be traced back to the specific emission, identifying the characteristics, the respective construction drawings, the maintenance in progress simply by linking the tag prepared for the LDAR campaign with the plant tag.
New digital tools are being developed to assist LDAR campaigns and can also be developed to create databases to which specific emission factors can be associated for specific plant units or process equipment, so that emissions can be calculated using bibliographic factors that are aligned with plant characteristics, reducing the costs of subsequent monitoring campaigns. In addition to the survey of fugitive leaks, for the reduction of methane emissions must be included the process venting leaks (including those from pneumatic instrumentation) or accidental leaks, for which some best practices for the design and operation phase are reported in the previous paragraphs of this report.
New ways for the direct identification of emission sources are through the use of IR cameras (or optical gas imaging - OGI) or drones, which are equipped with GPS for the direct georeferencing of the source.
Like any technology, the use of IR cameras or drones can be difficult to use in case of congestion of the sources, for example if they are positioned on a rack, where even the association of the GPS tag becomes difficult to implement.
A methodological proposal for the continuous detection of methane leaks is described at the end of the paragraph 7.3, regarding the installation of a network of geolocated electronic noses connected to a wireless control unit and to the company GIS portal, with the aim not only of identifying emissions, but also of understanding their concatenation with plant events and any implications for safety.

8.3 FIELD MEASUREMENTS

Field measurements for monitoring fugitive emissions or methane emissions occur through the use of different methodologies, some of which are under development or being deployed such as the use of satellites and drones, while others have been established for years such as the use of portable FID detectors according to the EPA 21 method through EN 15446. The use of IR cameras has developed extensively and is being refined to be able to quantify emissions (QOGI36).
The consolidated methodologies use FID or PID detectors for the measurement of emissions and are, to date, the best methodologies for the determination of emissions given the reduced instrumental dimensions and the wide instrumental availability as well as technological progress over the years, being instrumental methodologies widely used also for the analytical detection of other chemical compounds.

8.3.1 Sniffing methodologies

Flame Ionization detection

As already mentioned at the beginning of this paragraph, the most widely used technique is sniffing using the FID (Flame Ionization Detection) instrumentation recommended and developed by EPA and known as “Method 21”, widely adopted for the quantification of emissions, and known in Europe as EN 15446:2008.
The FID is a hand-held instrument (Figure 8.4) that can be used directly in the field to measure emissions from the previously classified and TAG-equipped source as part of the LDAR program.

Figure 8.4: Sniffing with FID

Photo Ionization detection (PID)

A similar method to FID is that based on the photo-ionization detector or PID, both related to absorption in the UV absorption range of hydrocarbon molecules.
Data processing downstream of the field measurements and cataloguing according to the specific emission source is carried out using the EPA Correlations Approach methodology, which takes into account the measurements made.

Pros:
- Detection range is between of 10 ppmv to 100,000 ppmv
- The method is well established and most widely used to obtain a detailed census of fugitive emissions
- To date, it is the best application to carry out a real census of fugitive emissions and/or hydrocarbons/methane.

Cons:
- For hydrocarbon concentrations > 100,000 ppmv a dilution probe must be used
- The measurement must be performed by one operator, per emission source, with economic burden due to field activities
- Remote measurement is not possible, so it will not be possible to measure emission loss in inaccessible locations.

IR camera (OGI)

The OGI Optical gas imaging camera uses the IR spectrum, between 3.2-3.4 ?.m, to identify hydrocarbons.
An IR camera can usually find only large VOC emitting components while the EPA 21 (FID) method can intercept both small and large emitters (0-100,000 ppmv).

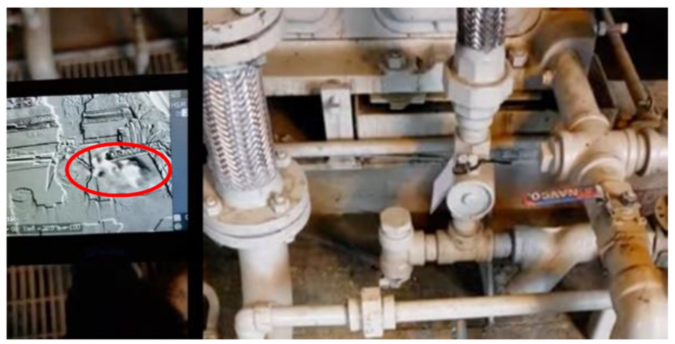


Figure 8.5: Detecting an emission with OGI camera

The limitations of the camera are related to weather conditions that may hinder the implementation of IR OGI inspection, such as monitoring distance and wind reduce the probability of detecting the emission (the detectability is inversely proportional to distance and wind speed). Figure 8.5 shows the use of the OGI camera for leak detection.
Other meteorological conditions that interfere with the detectability of VOCs with IR OGI are air temperature, humidity, cloud cover, and solar radiation.
Furthermore, a given gas is detectable if its infrared absorption spectrum overlaps with the absorption band of the thermal imaging camera, which must therefore be calibrated for the IR spectrum of the substance to be detected.
NTA 8399:2015 (Guidelines for detection of diffuse VOC emissions with optical gas imaging) is a European reference document that addresses the various issues for the use of OGI technology, providing useful guidance for planning a smart LDAR program.

Pros:
- Unreachable or difficult to reach sources
- Leaks from fixed or floating roof tanks and vessels
- Emissions from equipment and isolated lines
- Leaks during commissioning of the system.

Cons:
- Technology not yet able to quantify losses accurately
- With good gas dispersion this may not be detected
- The instrumental detectability is related to the resolution of the IR sensor
- The detection limit varies depending on the ambient temperature and the distance from the source

A methodology has been developed to associate specific emission factors to the different types of equipment surveyed, based on whether leakage is detected or not. In fact, the methodology is called OGI leak/no-leak which leads back to the use of emission factors only in case of leak detection or not.

There are applications to quantify (QOGI) emissions identified via IR camera by interfacing the camera to a device that interprets IR images of leaks are analyzed with respect to intensity on a pixel basis.

Drones
With the continued evolution in the development of Unmanned Aerial Vehicles (UAS) known as “drones”, they have been specially equipped with cameras suitable for use, for monitoring methane and other hydrocarbon emissions (Figure 8.6).

Figure 8.6: Drone leak detection

Through the use of these small vehicles, it is possible to monitor areas that are difficult to access and have an adequate response in terms of reliability of the data detected.
The possibility to use this technology could also obviate the execution of the preliminary census of the emission sources, with the possibility to identify the emitting source, to catalogue it in order to insert it in the repair program, since with the drone it is possible to directly perform the georeferencing of the emission point.
The drone can be equipped with an IR camera with detection limits of 5 ppm and measurement ranges up to 50,000 ppm and allows measurements even with distances from the source of 100 meters.

Pros:
- Possibility to operate remotely, in case of inaccessible areas
- Ability to monitor an entire site in a relatively short time

Cons:
- Need for specific flight authorizations
- In the case of close sources there may be interference

REFERENCES

To preserve the coherence with the full report, the numbering of the references has been maintained, even if some references are skipped in this version.

[1] Global Ambition: scenario developed by ENTSOs (inside TYNDP 2020) in compliance with the objectives of containing the temperature within 1.5 °C envisaged by the Paris Agreement, with a more centralized vision of the energy system, where, in addition to the development of renewables, the contribution of decarbonized gases, in particular hydrogen and biomethane, is of importance. The "Global Ambition" scenario was published in July 2020 in the ENTSOs document "TYNDP 2020 Scenario Report" and can be consulted at the link https://2020.entsos-tyndp-scenarios.eu/. The latest version is available at the link https://2022.entsos-tyndp-scenarios.eu/
[*2] National Trend Italia (NT Italia): scenario developed by Snam and Terna coherently with the National Trends scenario (NT ENTSOs), together with some necessary refinements and updates. In particular the reference grid and the electricity generation sector foreseen for 2030 in the Global Ambition scenario are consistent with the developments envisaged by the "Guidelines for the national strategy on hydrogen". By 2040, biomethane and hydrogen are worth respectively 9.3 and 7.3 billion cubic meters per year (Figure 3.6).
[*4] Source: European Environment Agency: Annual European Union greenhouse gas inventory 1990-2019 and inventory report 2021 https://www.eea.europa.eu/publications/annual-european-union-greenhouse-gas-inventory-2021
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[17] 2021 report is available at the link: https://www.api.org/~/media/Files/Policy/Environment/TEP/2021/The-Environmental-Partnership-2021-Annual-Report.pdf
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The acronyms of Methane Emissions

AIA	Autorizzazione Integrata Ambientale
AIV	Acoustic Induced Vibrations
AMB	Active Magnetic Bearing
API	American Petroleum Institute
ATEX	Atmosphere Explosive
BAT	Best Available Technology
bcm	Billions of Standard cubic meters
BREF	BAT Reference Document
BTEX	Benzene, Toluene, Ethylbenzene e Xylene
BVLOS	Beyond Visual Line Of Site
CAPEX	Capital Expenditure
CCAC	Climate and Clean Air Coalition
CCUS	Carbon Capture, Utilization, and Storage
CEN	Comitato Europeo di Normazione
cfm	cubic feet per minute
CIG	Comitato Italiano Gas
CNG	Compressed Natural Gas
COP26, COP27...	Conference of the parties (UN Climate Change Conference)
DCS	Distributed Control System
DEG	Diethyleneglicol
DNF	Dichiarazione di carattere Non Finanziario
EDF	Environment Defense Fund
ENTSO	European Network of Transmission System Operators
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSO-G	European Network of Transmission System Operators for Gas
EPA	Environmental Protection Agency
EPC	Engineering, Procurement & Construction
ESA	European Space Agency
ESD	Emergency Shut Down
ESG	Environmental, Social and corporate Governance
FEED	Front End Engineering Design
FID	Flame Ionization Detector
FIV	Fluid Induced Vibrations
FPSO	Floating Production, Storage and Offloading
FSRU	Floating Storage and Regasification Unit
GA	Global Ambition
GEME	Group of Expert on Methane Emissions
GHG	Greenhouse gas
GIS	Geographical Information System
GMP	Global Methane Pledge
GNL	Gas Naturale Liquefatto
GOSAT	Greenhouse gases Observing Satellite
GOSP	Gas Oil Separation Plant
GPS	Global Positioning System
GRI	Gas Research Institute
GRU	Gas Recovery Unit
GWP	Global Warming Potential
HIPPS	High Integrity Pressure Protection System
IIRC	International Integrated Reporting Council

ILI	In Line Inspection
IR	InfraRed
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale
JT	Joule Thompson
KPI	Key Performance Indicator
LDAR	Leak Detection And Repair
LTS	Low Temperature Separation
MEF	Major Economies Forum
MGP	Methane Guiding Principles
MiTE	Ministero della Transizione Ecologica
mmscf/d	Millions of standard cubic feet per day
MRV	Monitoring, Reporting and Verification
Mtep	Milioni di Tonnellate Equivalenti di Petrolio
NIR	National Inventory Report
NT	National Trend
NTA	Netherlands Technical Agreement
OGCI	Oil & Gas Climate Initiative
OGI	Optical Gas Imaging
OGMP	Oil & Gas Methane Partnership
ONG	Organizzazioni Non Governative
OPEX	Operative Expenditure
P&ID	Piping & Instrumentation Diagram
PID	Photo Ionization Detector
PID controller	Proportional Integral Derivative controller
ppb	Parts per billion
ppmv	parts per milion by volume
PSV	Pressure Safety Valve
PVC	Polivinylchloride
QOGI	Quantitative Optical Gas Imaging
RBI	Risk Based Inspection
RSU	Rifiuti Solidi Urbani
RTTM	Real Time Transient Model
SLPM	Standard Liters Per Minute
SOCMI	Synthetic Organic Chemical Manufacturers Industries
SVI	Shunt Vacuum Interruption
TC	Technical Commitee
TCFD	Task force on Climate-related Financial Disclosures
TEG	Triethyleneglycol
TGD	Technical Guidance Document
TRFL	Technische Regel für Fernleitungen
TROPOMI	Tropospheric Monitoring Instrument
TYNDP	Ten-Year Network Development Plans
UAS	Unmanned Aerial Vehicle
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US-EPA	United States Environmental Protection Agency
UV	UltraViolet
VLOS	Visual Line Of Site
VOC	Volatile Oil Compounds
VRU	Vapor Recovery Unit